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WE BLEND

WE AGE AGAIN

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Why? For extra smoothness.

It takes longer and costs more but aging, blending and aging again is the gold standard when it comes to marrying forty different single malts and grains into one super smooth Dewar's.

LIVE TRUE

CONTENTS

On the Cover
The Nature Conservancy bought Dugout Ranch, the largest private landholding within Utah's Bears Ears National Monument, to keep it from developers. Matt Redd, who directs a Conservancy research center, also tends the ranch's cattle. AARON HUEY

PROOF

EMBARK

EXPLORE

FEATURES

NAT GEO TV

Trek Into the Field on the New Season of *Explorer*

Follow new *Explorer* host Phil Keoghan—well known for his work on television's *The Amazing Race*—as he travels to the Himalaya, the Amazon, and other intriguing spots to meet National Geographic explorers on the front lines of research and adventure. Now in its 11th season, *Explorer* is part of a multiplatform project that includes an online field-journal forum, as well as live events. The season premiere airs November 12 at 10/9c on National Geographic.

BOOKS

See the World Like Never Before

Ready to be enlightened? The 2019 *National Geographic Almanac* is a great place to start. New discoveries and top travel trends share space with deep dives into topics such as the science of addiction. Thanks to brilliant photographs, infographics, and illustrated time lines, the workings of the world have never looked better. Available where books are sold and at *shopng.com/books*.

INSIDE THE ALMANAC

LIFE SCIENCE TIME LINE

THIS CORN POPPY is among the more than 500 plants featured in Italian herbalist Benedetto Rinio's botanical encyclopedia, *Liber de Simplicibus,* published in 1419.

IN A.D. 77 ROMAN SCHOLAR Pliny the Elder created Naturalis Historia, a treatise on natural history, which includes this illustration of music-making angels.

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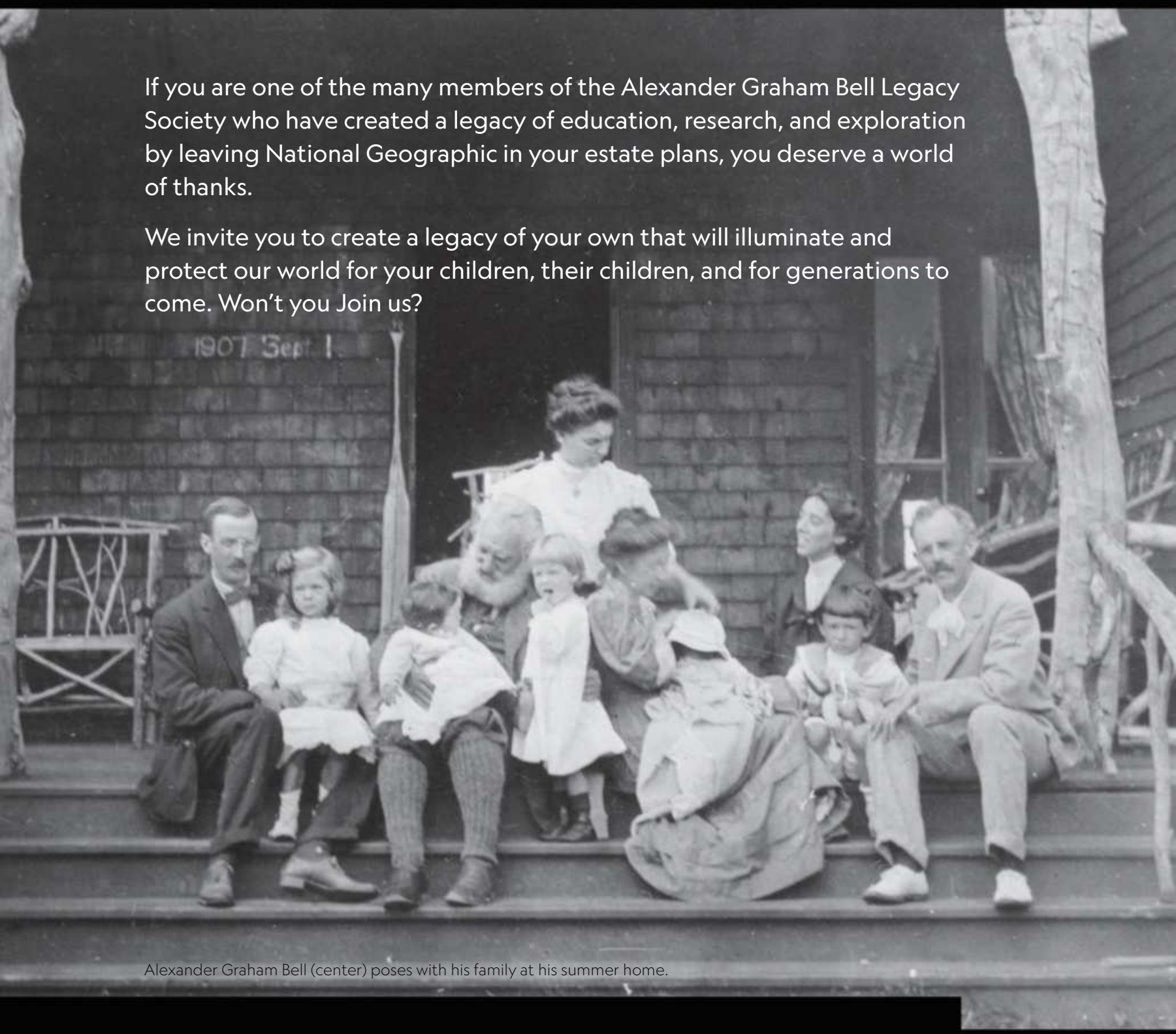

Alexander Graham Bell (center) poses with his family at his summer home.

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NATIONAL GEOGRAPHIC

BILL AND MELINDA GATES

Keeping Goals in Sight

INTERVIEW BY **SUSAN GOLDBERG** PHOTOGRAPH BY **BRINSON+BANKS**

In 2015 at the United Nations, world leaders adopted 17 goals aimed at reducing poverty, inequality, and other global ills by 2030. Such goals have long been championed by philanthropists **Bill and Melinda Gates.** So in 2017 the Gates Foundation launched Goalkeepers, an initiative to spur action and track progress toward the goals. Its 2018 status report says there have been "mind-blowing improvements in the human condition"—but it also calls for more investment and innovation in fighting poverty lest progress against it stall. I recently sat down with the Gateses for a rare joint interview on the new report.

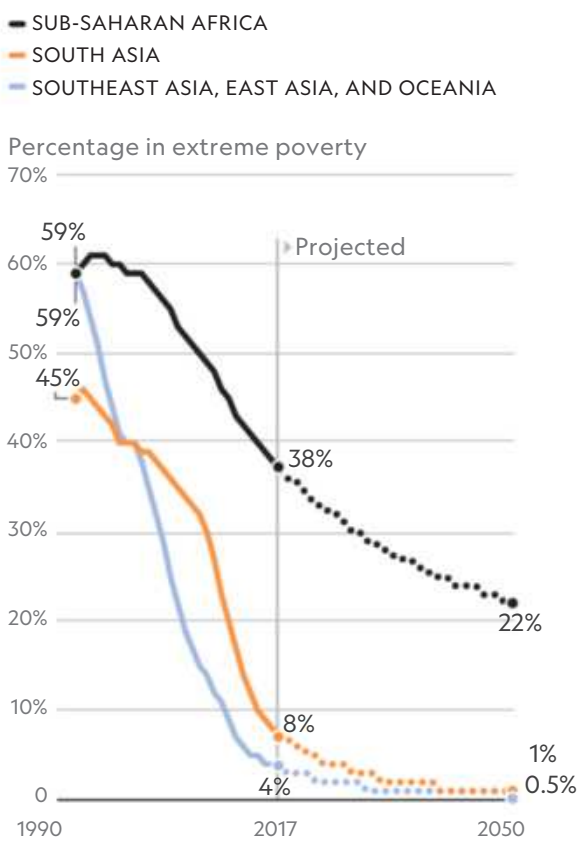
Susan Goldberg: **I've just read the Goalkeepers report. Why did you decide to start doing this?**
Melinda Gates: Because we think that the news—that the world has made this incredible progress, this increase in lives saved, the reduction in poverty—that news isn't really out there. The UN set these amazing goals for the future to help us continue to reduce poverty, and we want to make sure that we hold people accountable for that progress and really inspire the next generation of leaders who are going to take these tasks on.

One of the things I liked about the report is that the audience is treated as adults—you're saying there are some areas where it's really tough and we're not making as much progress as we'd like. You talk specifically about how while poverty is going down everywhere, it's not going down quite as fast in Africa.

'OPTIMISM IS IMPORTANT BECAUSE IT'S A FORM OF SEEING WHAT'S POSSIBLE AND THEN HELPING MAKE THAT A REALITY.'
—MELINDA GATES

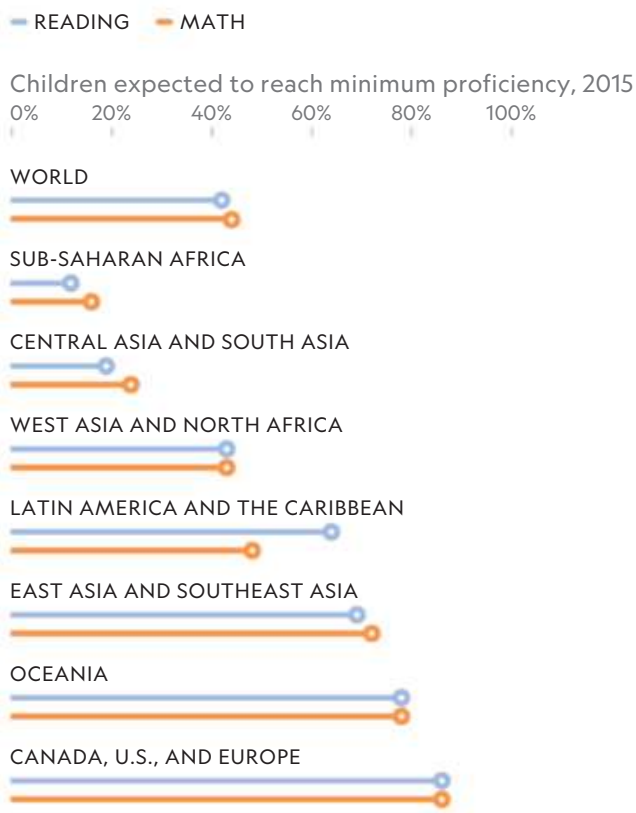
POVERTY

The percentage of people living in extreme poverty has declined—but less rapidly in sub-Saharan Africa, where poverty is concentrated in a few fast-growing nations.



ACADEMIC ACHIEVEMENT

The number of children not in school has decreased in every region of the world. Now the focus is on the quality of the education they receive.



MG: When we travel on the continent, we see this unbelievable potential, particularly with the young people coming up who have so much energy and ingenuity. But the reality is there's also poverty. And so how do you make sure that the progress that we're seeing that's moving forward in places like Rwanda or Ethiopia, that it reaches everybody? And that the lessons that are being learned in certain countries are spread?

What are you seeing in different countries? Who's doing a great job?

Bill Gates: Even a very poor country can do a good job on health, can do a good job on agriculture, on education. That provides a lot of hope because you can copy what's being done there. Rwanda has been a big outlier in the quality of those health services. Ethiopia, on agriculture, is growing over 5 percent a year. In education Vietnam is one we talk about, because they're so far ahead of where you'd expect given their wealth. But it's when you get those three things together—health, education, agriculture—that eventually these countries can become self-sufficient.

MG: One of the things that's also encouraging: [In population] Rwanda is a very small country, Ethiopia is the second largest on the continent of Africa—but they have learned the lessons of what has helped people make progress from around the world. So they're looking at what happened in Asia in agriculture, how did Brazil decrease the stunting rate [among malnourished children] so phenomenally across a very large country with lots of poverty.

When you think about learning from one another, I was struck by the example from Vietnam, where you've got 15-year-olds who are doing as well on international tests in school as people from the United Kingdom or from the United States. What are the lessons from Vietnam that can translate across other countries?

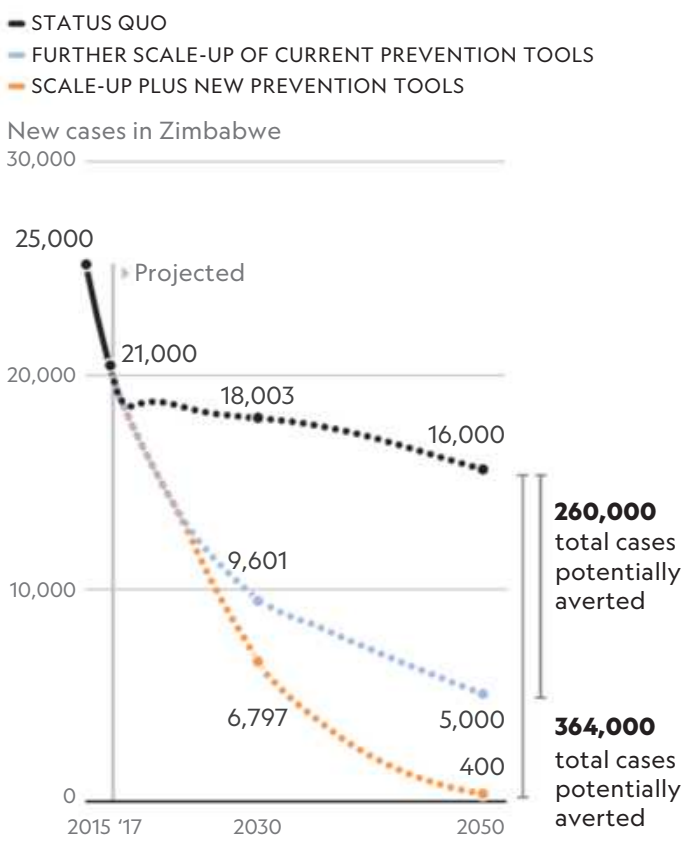
BG: It's a really new thing to try and get into the amount of learning. The agenda for poor countries up until now has largely been to get the kids into school—and attendance rates have gone up a lot, for girls and boys. The biggest missing piece still is how much knowledge they're gaining. A few countries, by training the teachers the right way and bringing the right material into the classroom, have really achieved learning way beyond what you might expect.

MG: When you look back at the UN millennium goals that were set [in 2000], one of the goals was to get kids into school. And that has essentially been achieved, particularly at the primary level and quite a bit at the secondary level. So it's neat to see a goal achieved, but now with this next set of goals, it's about how to get the depth of learning and the education right.

See video of this interview at *natgeo.com/gates*.

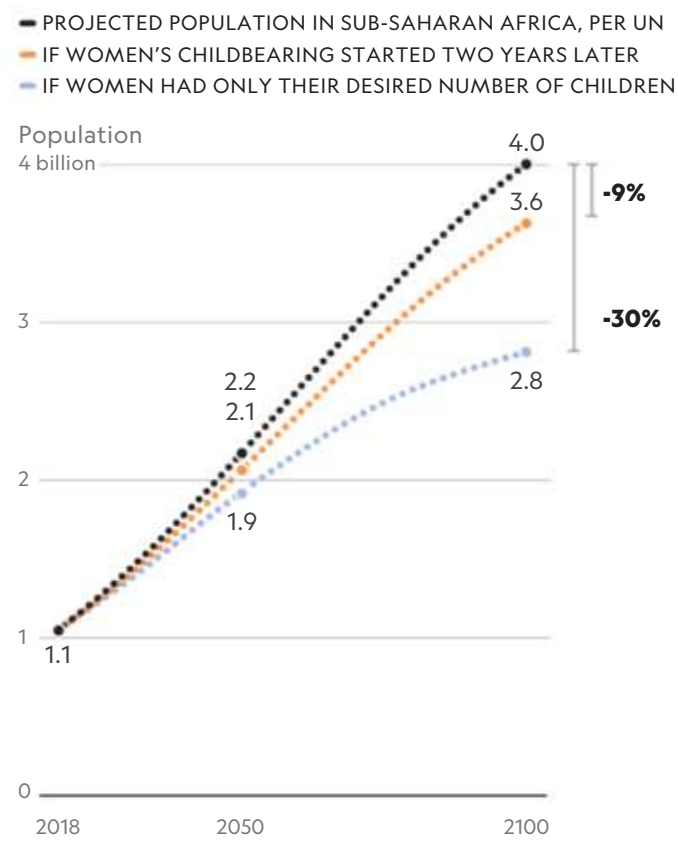
HIV CASES

As Africa's population grows, HIV cases may also, absent stepped-up prevention. One success story is Zimbabwe, where efforts have sharply reduced infection rates.



PROJECTED POPULATION

Africa's population is projected to double by 2050. Access to family planning would help slow growth, allowing more investment in health and education.



Thinking about the African continent: How young it is, how many young people there are, is both a huge challenge and a great opportunity. Can you talk a little bit about that?

BG: The African continent today is about a billion people out of the some seven billion on Earth. As this century goes forward, over half the young people in the entire world will be there. With those people moving into the job market, if the right investments are made—stability, education, health—Africa will have growth and innovation, far more than lots of other places. If, on the other hand, we don't take care of the HIV crisis, then you'll just have more people who will get infected. If you don't have the right conditions, then the young people, particularly the men, can add to that instability. So Africa definitely hangs in the balance.

You mentioned the HIV crisis. What are the differences in how African countries are handling it?

BG: The southern and eastern parts of Africa bore the brunt of the epidemic: 80 percent of the cases are there, and so the prevalence is very high. In lots of places a majority of women are infected by the end of their 20s. It's made a huge difference to get [antiretroviral] drugs into countries; the death rate has gone down a lot. Mother-to-child transmission of the virus—a lot of countries have done well to reduce that. You have some stigmatized communities, like drug-using communities or sex workers or men who have sex with men. Now we have to look at every country and say, OK, are they doing a good job with the different communities? What are the prevention tactics that are working?

MG: One of the biggest concerns, as Bill said, is for young women; there's so much AIDS in the community, and their chance of acquiring it is very high. So it's important to continue to get the messages out about what you can do to protect yourself, getting yourself tested. And the other message that really needs to be out there is about family planning tools, and that's even separate from HIV/AIDS. It's important for many reasons.

Melinda, this has been one of the issues that you're most involved in. Can you talk to me a little about that?

MG: Family planning is crucial anywhere, in any community around the world, because if a woman can decide if and when to have a child, she's going to be healthier and her child is going to be healthier. That's one of the longest-standing pieces of global health research we have. What struck me the most when traveling in Africa is that women know about contraceptives and want access, but contraceptives just aren't being delivered in the ways or the places that these women need. Since 2012 we now have 40 million additional women on contraceptives. That's progress, but not enough progress; we need to get 200 million women access to contraceptives.

When you do that, people have the chance to lift

NGM STAFF. SOURCE: BILL & MELINDA GATES FOUNDATION

their families out of poverty. Because if they can space the births of those children, they can then feed them, they can educate them, the woman can work and contribute her income to the family. It changes everything in the family dynamic, and it changes the community, and ultimately you get these country-level effects where it's good for everybody.

You've both gone all over the world and seen the problems up close. If you could wave a magic wand and fix just one thing, what would it be?
MG: I would say certainly contraceptives: giving a woman access to contraceptives so she can choose which one she wants to use at which points, so that she can space the births of her children. It changes everything for her and her children. So if I could wave a magic wand, 200 million women who are asking us for contraceptives today would have them.

Bill, what would yours be?
BG: The development of children. Today more than half the kids in Africa never fully develop physically or mentally because of malnutrition, their diet, and the diseases they face. With research on the human gut microbiome, we're gaining an understanding of stunting, why they don't grow. *[Editor's note: See the facts—and the faces—of malnutrition, at right.]* I'm superexcited that by the end of the decade we expect to have cheap interventions so those kids will fully develop. That means all the investments you make in their education, wanting to benefit from their productivity, will work far better. So if there was just one thing, it's the intervention to stop malnutrition.

As we close, I wanted to ask about this notion of optimism that is threaded through your report.
BG: The constant increased visibility of negative things gives people a misimpression. You might even conclude that it's kind of hopeless—but that's a mistake. You really need to learn from what's gone so well. As we've gotten vaccines out, miraculous things are happening. Literacy levels all over the world, including in Africa, have gone up very dramatically. A few of the problems are daunting. But maybe there's a new innovation; maybe there's a group of young people coming up with a new way of doing it—that's an attitude that you really want to get engaged, not discouraged.

MG: Optimism is important because it's a form of seeing what's possible and then helping make that a reality. With the earlier goals that were set, we can measure what has happened over the last 20 years, and we see the progress. We see it in the numbers, we see it in the reports, but we also see it with the people on the ground. We see this amazing ingenuity, and if we can tap that as a world—wow, will things change!

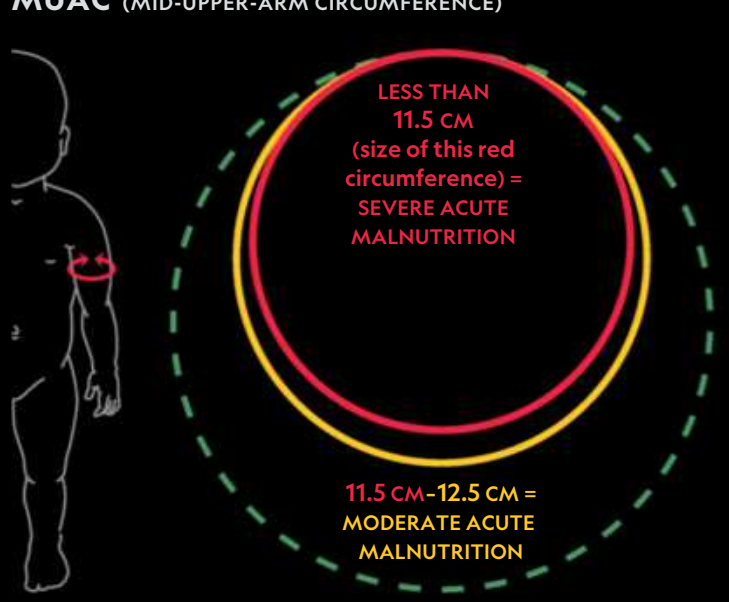
***

Thank you for reading *National Geographic*.

WHEN CHILDREN LACK NUTRITION

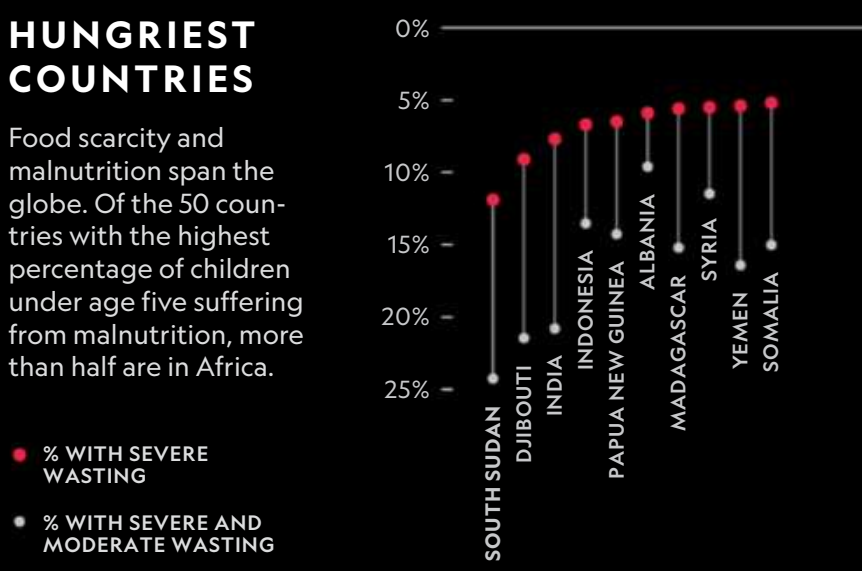
This is childhood malnutrition at life-size: Each of these children is severely malnourished—and the red circle around each photo equals the circumference of that child's arm. The circle is much larger if a child is not malnourished, as the key below shows.

Despite some gains against global hunger, malnutrition in children under age five left 22.2 percent of them stunted (too short for their age) and 7.5 percent of them wasted (too thin for their height) in 2017. UNICEF's Diane Holland says catching acute malnutrition early is key to bringing children back to healthy growth. The "MUAC bracelet" (right), used to measure mid-upper-arm circumference, helps gauge the severity of acute malnutrition so a child can be given lifesaving treatment and care.



HUNGRIEST COUNTRIES

Food scarcity and malnutrition span the globe. Of the 50 countries with the highest percentage of children under age five suffering from malnutrition, more than half are in Africa.



8.7 cm
(MUAC circle in life-size)
East Ghouta
SYRIA, 2017

Under siege since 2013, this outer district of the country's capital is a focal point of the civil war. Humanitarian groups are unable to regularly access the nearly 400,000 people who live there.

9.0 cm
Juba
SOUTH SUDAN, 2017

This two-year-old child was given a weekly food-aid supply after being diagnosed with severe malnutrition. The country has been mired in a dev-astating civil war for more than four years.

10.0 cm
Chelhar
PAKISTAN, 2015

Extreme heat in summer, food scarcity, unsafe drinking water, and lack of access to health facilities in rural Pakistan cause high rates of malnutrition among children, including this seven-month-old.

10.5 cm
Dhamar
YEMEN, 2017

In the Middle East's poorest country, some 2.2 million children under age five are malnourished. As a result of the civil war, more than half the nation's medical facilities no longer operate.

10.9 cm
Muna Garage IDP camp
NIGERIA, 2016

Roughly 250,000 of Borno state's children face severe malnourishment as a result of the Boko Haram conflict. Widespread displacement has separated some 20,000 children from their parents.

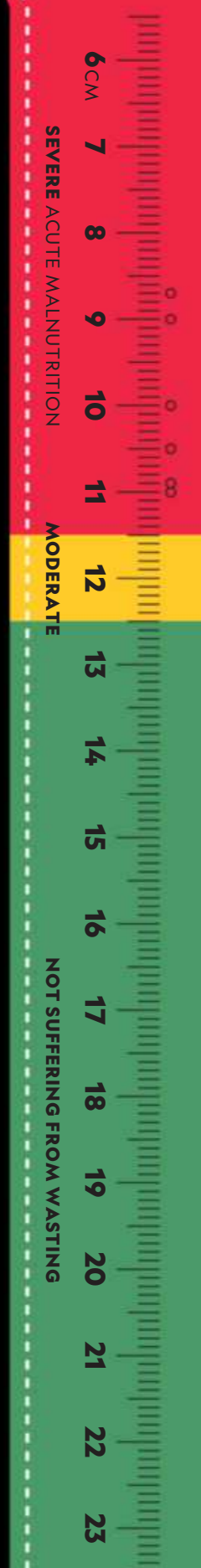
11.0 cm
Moinerghona refugee camp
BANGLADESH, 2017

Since August 2017, more than 700,000 Rohingya refugees have fled on foot to Bangladesh to escape violence. This 10-month-old's family left Myanmar after the country's military set fire to their village.

ALBERTO LUCAS LÓPEZ, NGM STAFF; KELSEY NOWAKOWSKI. SOURCES: DIANE HOLLAND, UNICEF; WHO; WORLD BANK
PHOTOS: UNICEF/UN0142215/TOM/OCHA (SYRIA); UNICEF/UN0152300/GONZALEZ FARRAN (SOUTH SUDAN); UNICEF/UNI186515/ZAIDI (PAKISTAN); UNICEF/UN057346/MADHOK (YEMEN); UNICEF/UN025789/ESIEBO (NIGERIA); UNICEF/UN0148012/KNOWLES-COURSIN (BANGLADESH)

Cut the bracelet along the dotted lines, and insert the bottom end into the horizontal slit to understand how MUAC bracelets are used.

FIGURES FOR CHILDREN **6-59 MONTHS**



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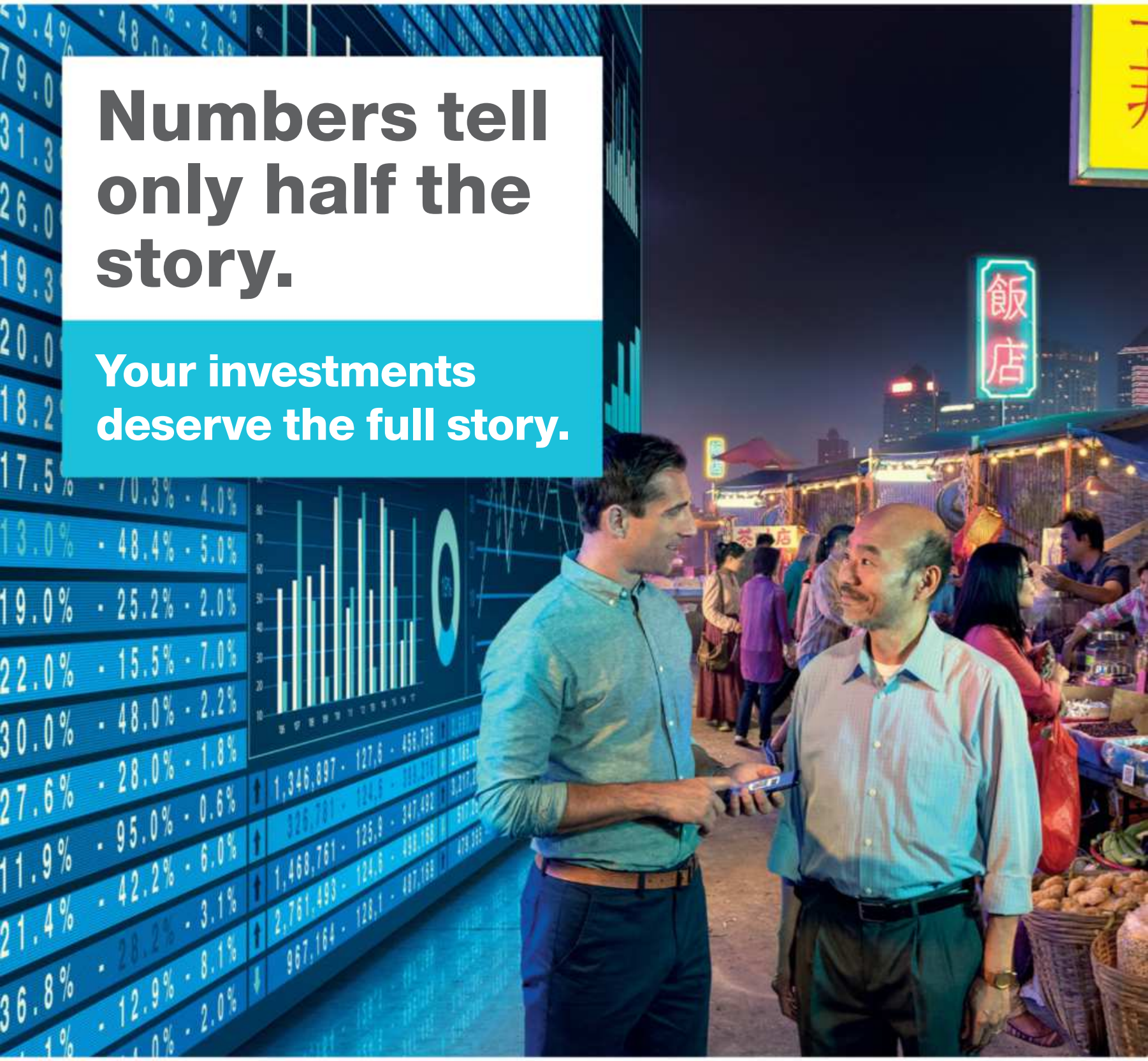

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PHOTOGRAPHS BY **STÉPHANE LAVOUÉ**

NATIONAL GEOGRAPHIC

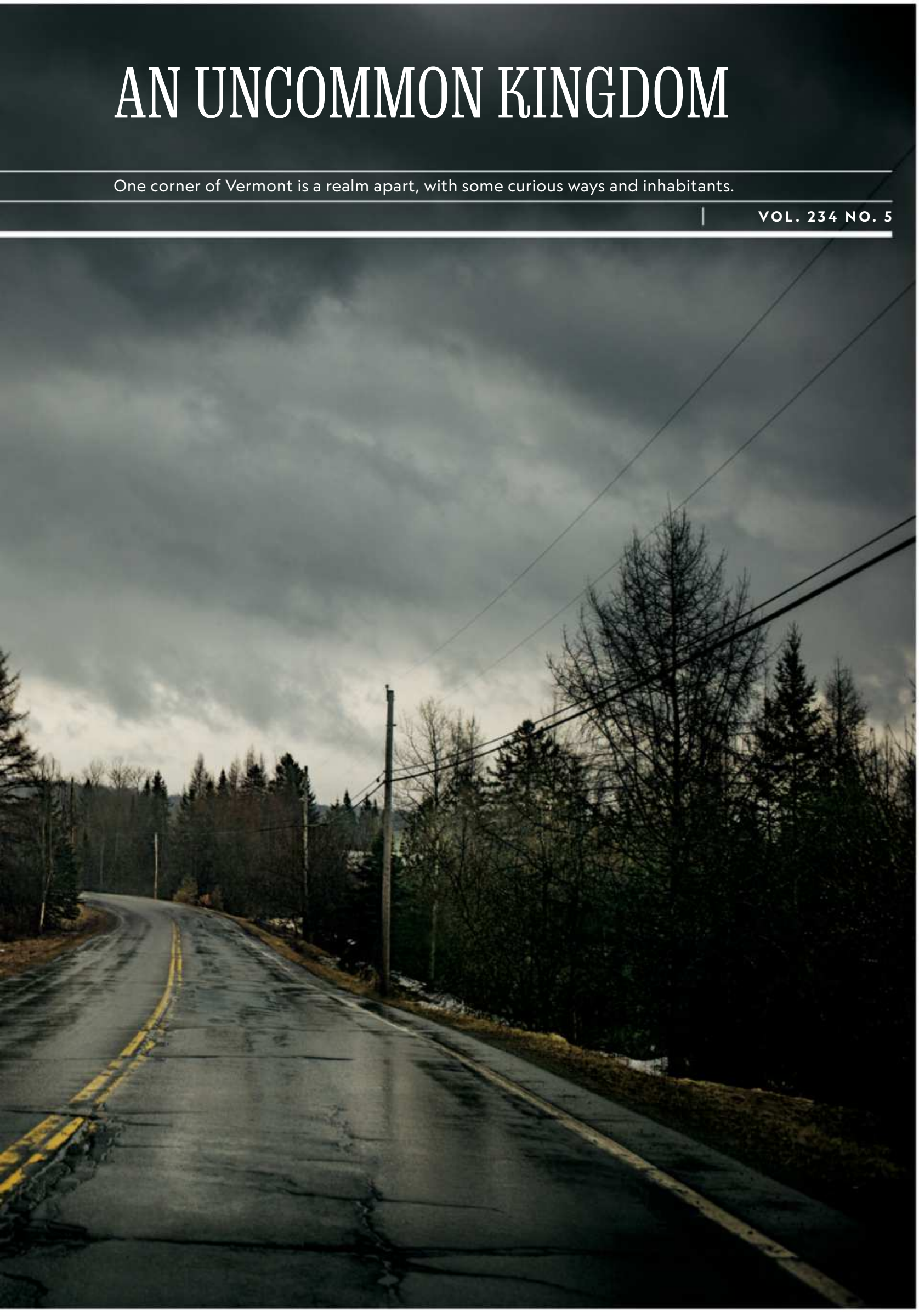
LOOKING AT THE EARTH FROM EVERY POSSIBLE ANGLE

For a photo project on the area Vermonters call the Northeast Kingdom, Stéphane Lavoué often drove this road and saw, he says, “more deer than human beings” on it.

AN UNCOMMON KINGDOM

One corner of Vermont is a realm apart, with some curious ways and inhabitants.

VOL. 234 NO. 5



William Eddy was an environmentalist, filmmaker, author, and teacher who “made the link between my fantasy and the reality of the Kingdom,” Lavoué says. Eddy died at his home there in 2016, at age 88.

Vermont writer Archer Mayor calls the Northeast Kingdom “a retreat for the eccentric.” One of its museums (top) specializes in everyday objects; another includes stuffed wildlife among its exhibits.

"In the Kingdom I imagined," Lavoué says, he gave fanciful titles to some residents. Josie Ann Monroe, a bow-and-arrow hunter who studied custom butchery and worked as a meat cutter, was "my princess."

Retiree Emelia Laramee, a widow, told Lavoué that she's "always lived" in the Northeast Kingdom. She chops the wood she uses to heat her home and to cook, so he nicknamed her the "Log Lady."

THE BACKSTORY

SEEKING A PLACE HOSPITABLE TO THE ECCENTRIC AND THE INDEPENDENT? CONSIDER THIS VERMONT KINGDOM.

THERE'S A HABIT in some of the more remote sections of Vermont's Northeast Kingdom. When you drive up to a person's out-of-the-way home, you honk your horn and wait before exiting your vehicle. So the dogs can gauge your intentions. It's a form of politesse. It's also not too dumb an idea.

Locals call it simply the Kingdom. The full title purportedly was bestowed in the 1940s by a politician. But whatever the origin, the place deserves a special label. Even in a state as different, occasionally ornery, and notoriously freethinking as Vermont, the Kingdom stands out.

In the state's northeast corner, it covers roughly 2,000 square miles, comprises three counties, and contains fewer than 64,000 people. Some 80 percent of it is forest. Distinct from the rest of Vermont in many ways, geologically it's more Canadian than not, an ancient tectonic collage carved by ice sheets, wedged under often querulous skies.

It's been said that in this cold country, the law has less to do with rules than with personal honor—sometimes one and the same, but not always. The land and climate are hard. The people tend to be frank. They live in the Kingdom because it suits.

Stéphane Lavoué, a French native now living in Brittany, came upon the Kingdom when visiting friends and took it as his project. I recognize the people he photographed—not as individuals or by name but as archetypal subjects of the Kingdom with its mysterious sense of otherness.

These are pragmatists. They make do, and they craft what they can't afford to buy. Most important, they are not hard-bitten or downtrodden by a harsh environment. The Kingdom is a choice, at once a retreat for the eccentric and a home to the independent.

When my editor asked if I knew what was in the Museum of Everyday Life (pictured on page 15), I said I did not—but wouldn't be startled if it were empty, a jest. I've since learned that it's a real museum with a collection reflecting its name, displaying everything from a safety pin to a kitchen match.

Still, it might have been empty, in keeping with the Kingdom's vaunted quirkiness. Those who dwell here may not have much money, but they're often rich in irony. **—ARCHER MAYOR**

Devoted Vermonter **Archer Mayor,** a death investigator for the state's Office of the Chief Medical Examiner, is the award-winning author of a series of crime novels starring Vermont detective Joe Gunther.

COUNTIES OF THE NORTHEAST KINGDOM

People in the Northeast Kingdom "do without what they don't need," says Archer Mayor. The area is less prosperous than the rest of Vermont; two of its counties have the highest rates of poverty in the state.

RILEY D. CHAMPINE, NGM STAFF

FROM EXECUTIVE PRODUCERS **BRIAN GRAZER** AND **RON HOWARD**

MARS

NEW SEASON

MONDAY NOV 12 9/8c

NATIONAL GEOGRAPHIC

IMFINZI SIGNIFICANTLY REDUCED THE CHANCE OF LUNG CANCER SPREADING

IMFINZI may not work for everyone.

IMFINZI was studied in 713 patients with unresectable Stage 3 NSCLC who completed at least 2 cycles of chemotherapy that contained platinum given at the same time (concurrent) as radiation before starting the trial. Patients in the study had good performance status (WHO 0 or 1). IMFINZI was tested against placebo (no medication).

The main goal of the trial was to measure the length of time people remained progression free (without cancer growing or spreading) and overall survival. At the time of analysis, overall survival comparison was not yet available. This trial is still ongoing.

WHO IS IMFINZI FOR?

IMFINZI® (durvalumab) is a prescription medicine used to treat a type of lung cancer called non-small cell lung cancer (NSCLC). IMFINZI may be used when your NSCLC has not spread outside your chest, cannot be removed by surgery, **and** has responded or stabilized with initial treatment with chemotherapy that contains platinum, given at the same time as radiation therapy.

It is not known if IMFINZI is safe and effective in children.

IMPORTANT SAFETY INFORMATION

What is the most important information I should know about IMFINZI?

IMFINZI is a medicine that may treat a type of lung cancer by working with your immune system.

IMFINZI can cause your immune system to attack normal organs and tissues and can affect the way they work. These problems can sometimes become serious or life-threatening and can lead to death.

Call or see your healthcare provider right away if you develop any symptoms of the following problems or if these symptoms get worse:

Lung problems (pneumonitis). Signs and symptoms may include new or worsening cough, shortness of breath, and chest pain.

Liver problems (hepatitis). Signs and symptoms may include yellowing of your skin or the whites of your eyes, severe nausea or vomiting, pain on the right side of your stomach area (abdomen), drowsiness, dark urine (tea colored), bleeding or bruising more easily than normal, and feeling less hungry than usual.

Intestinal problems (colitis). Signs and symptoms may include diarrhea or more bowel movements than usual; stools that are black, tarry, sticky, or have blood or mucus; and severe stomach-area (abdomen) pain or tenderness.

Hormone gland problems (especially the thyroid, adrenals, pituitary, and pancreas). Signs and symptoms that your hormone glands are not working properly may include headaches that will not go away or unusual headaches; extreme tiredness; weight gain or weight loss; dizziness or fainting; feeling more hungry or thirsty than usual; hair loss; feeling cold; constipation; your voice gets deeper; urinating more often than usual; nausea or vomiting; stomach-area (abdomen) pain; and changes in mood or behavior, such as decreased sex drive, irritability, or forgetfulness.

Kidney problems, including nephritis and kidney failure. Signs of kidney problems may include decrease in the amount of urine, blood in your urine, swelling of your ankles, and loss of appetite.

Skin problems. Signs may include rash, itching, and skin blistering.

Problems in other organs. Signs and symptoms may include neck stiffness; headache; confusion; fever; chest pain, shortness of breath, or irregular heartbeat (myocarditis); changes in mood or behavior; low red blood cells (anemia); excessive bleeding or bruising; muscle weakness or muscle pain; blurry vision, double vision, or other vision problems; and eye pain or redness.

WITH STAGE 3 LUNG CANCER

I'M IN WITH IMFINZI

TO CONTINUE FIGHTING MY CANCER AFTER CRT

FIRST & ONLY TREATMENT APPROVED

for people with unresectable Stage 3 non-small cell lung cancer (NSCLC) whose disease has not progressed following concurrent chemoradiation therapy (CRT).

IMFINZI is an immunotherapy. People receiving IMFINZI had a 48% lower chance of lung cancer growing or spreading than those receiving placebo (no medicine). It was also proven to give people 3x more time without their cancer spreading compared with placebo.* Before IMFINZI, the last 10 years showed only limited advancements to the current standard of care for unresectable Stage 3 NSCLC.

*In a clinical trial, the median time tumors did not grow or spread was 16.8 months for the 476 patients receiving IMFINZI compared with 5.6 months for the 237 patients receiving placebo. Median is the middle number in a group of numbers arranged from lowest to highest. Individual results may vary.

ASK YOUR DOCTOR ABOUT IMFINZI. VISIT IMFINZI.COM

Severe infections. Signs and symptoms may include fever, cough, frequent urination, pain when urinating, and flu-like symptoms.

Severe infusion reactions. Signs and symptoms may include chills or shaking, itching or rash, flushing, shortness of breath or wheezing, dizziness, fever, feeling like passing out, back or neck pain, and facial swelling.

Getting medical treatment right away may help keep these problems from becoming more serious. Your healthcare provider will check you for these problems during your treatment with IMFINZI. Your healthcare provider may treat you with corticosteroid or hormone replacement medicines. Your healthcare provider may delay or completely stop treatment with IMFINZI if you have severe side effects.

Before you receive IMFINZI, tell your healthcare provider about all of your medical conditions, including if you have immune system problems such as Crohn's disease, ulcerative colitis, or lupus; have had an organ transplant; have lung or breathing problems; have liver problems; or are being treated for an infection.

If you are pregnant or plan to become pregnant, tell your healthcare provider. IMFINZI can harm your unborn baby. If you are able to become pregnant, you should use an effective method of birth control during your treatment and for at least 3 months after the last dose of IMFINZI. Talk to your healthcare provider about which birth control methods to use. Tell your healthcare provider right away if you become pregnant during treatment with IMFINZI.

If you are breastfeeding or plan to breastfeed, tell your healthcare provider. It is not known if IMFINZI passes into breast milk. Do not breastfeed during treatment with IMFINZI and for at least 3 months after the last dose of IMFINZI.

Tell your healthcare provider about all the medicines you take. This includes prescription and over-the-counter medicines, vitamins, and herbal supplements.

What are the possible side effects of IMFINZI?

IMFINZI can cause serious side effects (see earlier).

The most common side effects in people with non-small cell lung cancer (NSCLC) include cough, feeling tired, inflammation in the lungs (pneumonitis), upper respiratory tract infections, shortness of breath, and rash.

Tell your healthcare provider if you have any side effect that bothers you or that does not go away. These are not all the possible side effects of IMFINZI. Ask your healthcare provider or pharmacist for more information.

Call your healthcare provider for medical advice about side effects.

You are encouraged to report negative side effects of prescription drugs to the FDA. Visit www.FDA.gov/medwatch or call 1-800-FDA-1088.

Please see Brief Summary of complete Prescribing Information on the following page.

If you cannot afford your medications, AstraZeneca may be able to help. Visit AstraZeneca-us.com to find out how.

IMFINZI®
durvalumab
Injection for Intravenous Use 50 mg/mL

AstraZeneca

IMPORTANT INFORMATION ABOUT IMFINZI® (im-FIN-zee) (durvalumab) INJECTION

IMFINZI™ durvalumab
Injection for Intravenous Use 50 mg/mL

WHAT IS THE MOST IMPORTANT INFORMATION I SHOULD KNOW ABOUT IMFINZI?

IMFINZI is a medicine that may treat a type of lung cancer by working with your immune system.

IMFINZI can cause your immune system to attack normal organs and tissues and can affect the way they work. These problems can sometimes become serious or life-threatening and can lead to death.

Call or see your healthcare provider right away if you develop any symptoms of the following problems or these symptoms get worse:

Lung problems (pneumonitis). Signs and symptoms of pneumonitis may include:

- new or worsening cough
- shortness of breath
- chest pain

Liver problems (hepatitis). Signs and symptoms of hepatitis may include:

- yellowing of your skin or the whites of your eyes
- severe nausea or vomiting
- pain on the right side of your stomach area (abdomen)
- drowsiness
- dark urine (tea colored)
- bleeding or bruising more easily than normal
- feeling less hungry than usual

Intestinal problems (colitis). Signs and symptoms of colitis may include:

- diarrhea or more bowel movements than usual
- stools that are black, tarry, sticky, or have blood or mucus
- severe stomach area (abdomen) pain or tenderness

Hormone gland problems (especially the thyroid, adrenals, pituitary and pancreas). Signs and symptoms that your hormone glands are not working properly may include:

- headaches that will not go away or unusual headaches
- extreme tiredness
- weight gain or weight loss
- dizziness or fainting
- feeling more hungry or thirsty than usual
- hair loss
- changes in mood or behavior, such as decreased sex drive, irritability, or forgetfulness
- feeling cold
- constipation
- your voice gets deeper
- urinating more often than usual
- nausea or vomiting
- stomach area (abdomen) pain

Kidney problems, including nephritis and kidney failure. Signs of kidney problems may include:

- decrease in the amount of urine
- blood in your urine
- swelling of your ankles
- loss of appetite

Skin problems. Signs of these problems may include:

- rash
- itching
- skin blistering

(continued)

Problems in other organs. Signs and symptoms may include:

- neck stiffness
- headache
- confusion
- fever
- chest pain, shortness of breath, or irregular heartbeat (myocarditis)
- changes in mood or behavior
- low red blood cells (anemia)
- excessive bleeding or bruising
- muscle weakness or muscle pain
- blurry vision, double vision, or other vision problems
- eye pain or redness

Severe infections. Signs and symptoms may include:

- fever
- cough
- frequent urination
- pain when urinating
- flu-like symptoms

Severe infusion reactions. Signs and symptoms of severe infusion reactions may include:

- chills or shaking
- itching or rash
- flushing
- shortness of breath or wheezing
- dizziness
- fever
- feel like passing out
- back or neck pain
- facial swelling

Getting medical treatment right away may help keep these problems from becoming more serious. Your healthcare provider will check you for these problems during your treatment with IMFINZI. Your healthcare provider may treat you with corticosteroid or hormone replacement medicines. Your healthcare provider may delay or completely stop treatment with IMFINZI, if you have severe side effects.

WHAT IS IMFINZI?

IMFINZI is a prescription medicine used to treat:

- a type of lung cancer called non-small cell lung cancer (NSCLC). IMFINZI may be used when your NSCLC:
  - has not spread outside your chest
  - cannot be removed by surgery, **and**
  - has responded or stabilized with initial treatment with chemotherapy that contains platinum, given at the same time as radiation therapy.

It is not known if IMFINZI is safe and effective in children.

Before you receive IMFINZI, tell your healthcare provider about all of your medical conditions, including if you:

- have immune system problems such as Crohn's disease, ulcerative colitis, or lupus
- have had an organ transplant
- have lung or breathing problems
- have liver problems
- are being treated for an infection
- are pregnant or plan to become pregnant. IMFINZI can harm your unborn baby. If you are able to become pregnant, you should use an effective method of birth control during your treatment and for at least 3 months after the last dose of IMFINZI. Talk to your healthcare provider about birth control methods that you can use during this time. Tell your healthcare provider right away if you become pregnant during treatment with IMFINZI.
- are breastfeeding or plan to breastfeed. It is not known if IMFINZI passes into your breast milk. Do not breastfeed during treatment and for at least 3 months after the last dose of IMFINZI.

(continued)

Tell your healthcare provider about all the medicines you take, including prescription and over-the-counter medicines, vitamins, and herbal supplements.

HOW WILL I RECEIVE IMFINZI?

- Your healthcare provider will give you IMFINZI into your vein through an intravenous (IV) line over 60 minutes.
- IMFINZI is usually given every 2 weeks.
- Your healthcare provider will decide how many treatments you need.
- Your healthcare provider will test your blood to check you for certain side effects.
- If you miss any appointments, call your healthcare provider as soon as possible to reschedule your appointment.

WHAT ARE THE POSSIBLE SIDE EFFECTS OF IMFINZI?

IMFINZI CAN CAUSE SERIOUS SIDE EFFECTS, INCLUDING:

SEE "WHAT IS THE MOST IMPORTANT INFORMATION I SHOULD KNOW ABOUT IMFINZI?"

The most common side effects of IMFINZI in people with NSCLC include:

- cough
- feeling tired
- inflammation in the lungs (pneumonitis)
- upper respiratory tract infections
- shortness of breath
- rash

Tell your healthcare provider if you have any side effect that bothers you or that does not go away.

These are not all the possible side effects of IMFINZI. Ask your healthcare provider or pharmacist for more information. Call your healthcare provider for medical advice about side effects. You may report side effects to FDA at 1-800-FDA-1088.

GENERAL INFORMATION ABOUT THE SAFE AND EFFECTIVE USE OF IMFINZI.

Medicines are sometimes prescribed for purposes other than those listed in a Medication Guide. If you would like more information about IMFINZI, talk with your healthcare provider. You can ask your healthcare provider for information about IMFINZI that is written for health professionals.

AstraZeneca

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US License No. 2043

This Patient Information has been approved by the U.S. Food and Drug Administration. Issued: 02/2018

THE DISCOVERIES OF TODAY THAT WILL DEFINE THE WORLD OF TOMORROW

NATIONAL GEOGRAPHIC | VOL. 234 NO. 5

A Sun-Powered Sail Into Space

IMAGINED BY ASTRONOMERS FROM JOHANNES KEPLER TO CARL SAGAN, A SOLAR-SAILING SPACECRAFT IS POISED FOR LAUNCH.

BY **BILL NYE**

DO YOU KNOW THE CURRENT phase of the moon? Most of us don't have any idea; nowadays we hardly need to know. But before there were streetlamps and electric lights everywhere, people watched the night sky diligently. So when a very bright comet appeared in 1607, people were frightened and fascinated.

German astronomer Johannes Kepler thought deeply about what he saw that year. He reasoned that the spectacular tail of what we now call Halley's comet (named after English scientist Edmond Halley, who computed its orbit) was probably caused by the sun's warmth somehow evaporating or liberating material from the comet's surface. Kepler imagined exploring those star scapes: "Given ships or sails adapted to the breezes of heaven, there will be those who will not shrink from even that vast expanse," he wrote.

Ships, after all, were common enough in the 16th and 17th centuries, and they were driven by

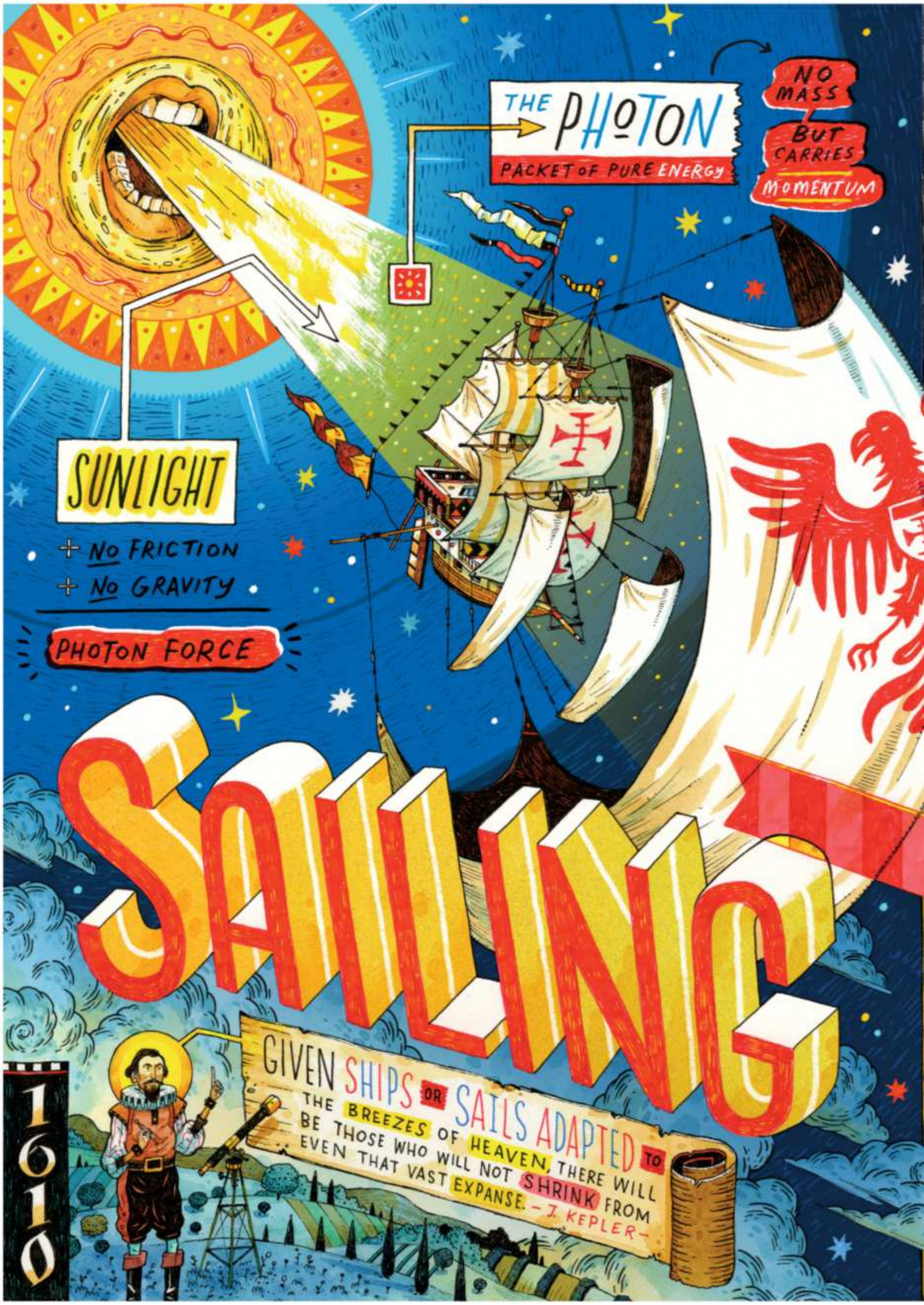
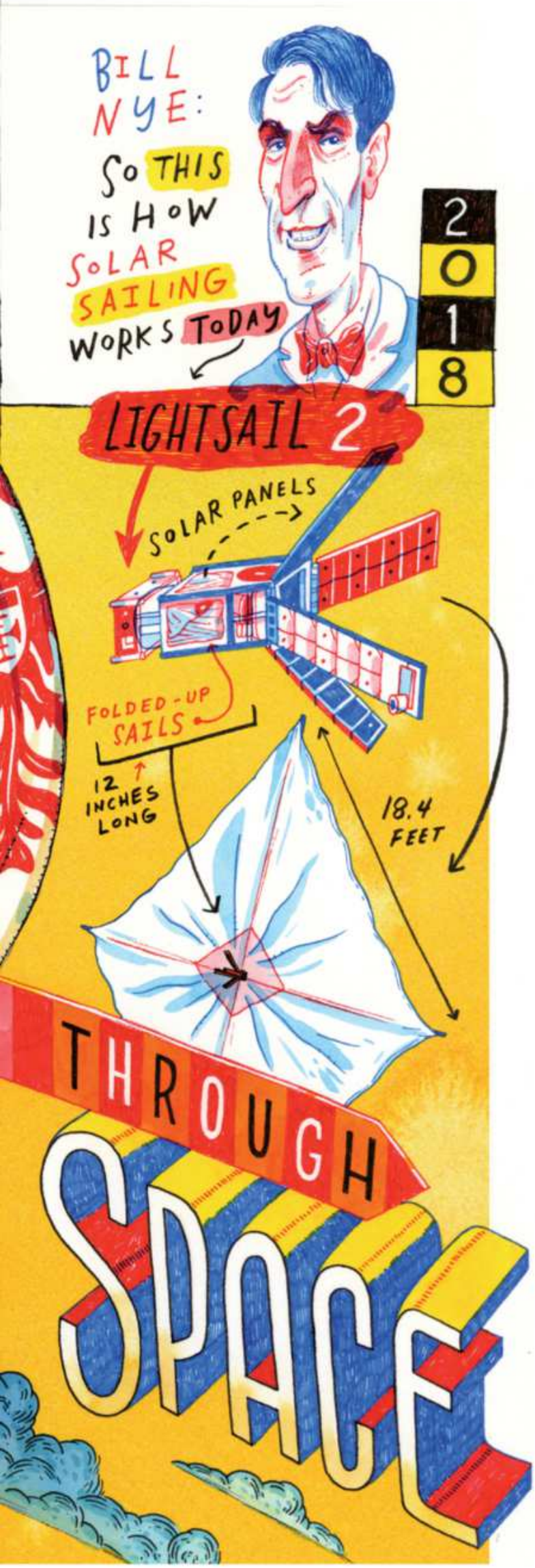


ILLUSTRATION: JOHN HENDRIX



the winds, which are themselves created in part by the sun's warmth. Kepler lived during a moment in history when, thanks to Nicolaus Copernicus, we came to understand that we're aboard a planet orbiting a star. Perhaps it was natural, then, for Kepler to envision humankind sailing the starry heavens.

As I sat in Carl Sagan's astronomy classes at Cornell University in 1977, sailing through space certainly seemed natural to me. Sagan vividly described his vision of a craft that could operate within the constraints of gravity and the mechanics of orbits, yet glide among the stars. It would sail the cosmic ocean, driven by the force of starlight in the vastness of space.

The dream that our professor outlined is now being realized by the Planetary Society, the world's largest nongovernmental space organization, which Sagan co-founded in 1980 (and I now lead). In June 2015 the society tested its own crowdfunded, flight-by-light spacecraft, LightSail 1. As this article goes to press, we're preparing for the scheduled autumn launch from Cape Canaveral of its successor, LightSail 2, to be vaulted into Earth orbit on the SpaceX Falcon Heavy rocket.

SOME THREE CENTURIES after Kepler first wrote about stellar sailing, scientists discovered that light is pure energy—that property in nature that makes things go, run, or happen. These days we know just how much energy is in each packet of light, or photon. Although photons have absolutely no mass, they nevertheless carry momentum.

We probably all recognize that a rolling bowling ball has momentum, which it transfers to bowling pins. When the ball strikes, the pins go down and the points rack up. Furthermore, if you were to experience a bowling ball rolling into your rib cage (as I did while appearing on a kids TV show), you'd notice its momentum quite strongly.

In contrast, the momentum of light is a concept outside our ordinary experience: When you're out in the sun, you don't feel that sunlight can push you around. The force of light, a single photon in particular, is tiny—so on Earth the sunlight pressure, as it's called, is overwhelmed by the other forces and pressures you encounter, such as friction and gravity.

What if we could harness the energy of a tremendous number of photons and we had nothing holding us back? There's only one place we know of to get away from all the friction and gravity: outer space.

Since the 1920s, people have imagined spacecraft that would be so low mass and so big that the pressure of photons would push them through space the same way molecules of gas—air—push sailing ships across the sea.

Solar sailing is elegant not only in concept but also in its efficiency. Once in orbit, there's no fuel needed. Although the propulsive force is quite small—barely nine micro-newtons (two-millionths of a pound) per square meter (or yard) of shiny sail—unlike a conventional rocket engine, it never runs out of fuel.

Because the sun shines around the clock, the small bit of energy imparted every second builds and builds.

Here's how LightSail 2 will fly. Our spacecraft starts no bigger than a loaf of bread: 4 x 4 x 12 inches, a standard size and shape for today's cubical satellites, or CubeSats. It's fun to realize that since there's hardly any air in Earth orbit, there's no need for spacecraft to have sleek, aerodynamic shapes.

Small compartments in the spacecraft hold very shiny sails; in orbit, they'll be unfurled to a square more than 18 feet on each side. As sunlight pushes the sails, ground control can cue the craft's very small electric motors to make it twist in space. As we orbit Earth, we will fly edge-on toward the sun, then twist or tack the spacecraft to present its sails right across the sunbeams, then tack again edge-on with each orbit.

It's just like a sailing ship except it's in space, driven directly by sunlight. And instead of being built in an enormous shipyard by the sea, the LightSail is built in small labs on land in California (albeit with access to some pretty good surfing).

DURING OUR LIGHTSAIL 2 mission, we anticipate building orbital energy so that our noble little craft will climb to a higher and higher orbit. We hope it will send back beautiful pictures of itself and the Earth below. And we believe it will fundamentally advance the technology of spaceflight. These LightSail missions are part of a global effort to lower the cost of space exploration, so missions could be flown that would otherwise be cost prohibitive or impossible.

For example: Now and then, the sun ejects an enormous amount of energy called a coronal mass ejection, or CME. These streams of charged particles, which can ruin the electronics aboard satellites, move very rapidly through space—but not nearly as rapidly as photons of light.

As Kepler himself pointed out, an object that is in close orbit to the sun goes faster than an object that's in orbit farther out, because of the sun's gravitational pull. If we were to attempt to put a satellite in an orbit at about the same distance from the sun as, say, Venus is, and we planned to have our spacecraft keep pace with the Earth—well, it wouldn't. Instead, it would literally fall into the sun. To stay in such an orbit, a spacecraft would need another constant outward force. A solar sail could provide that continuous push, and the instruments on board could detect a CME and send us a warning signal. We could maneuver nearby Earth-orbiting satellites so that they essentially turn their backs to the stream of particles—and our vital spacecraft would suffer little damage.

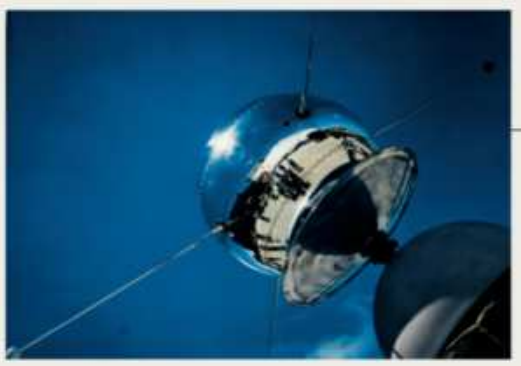
WE HOPE LIGHTSAIL 2 WILL SEND BACK BEAUTIFUL PICTURES. AND WE BELIEVE IT WILL FUNDAMENTALLY ADVANCE THE TECHNOLOGY OF SPACEFLIGHT.

With this same feature of solar sailing, we could send a spacecraft outfitted with infrared telescopes to orbit in step with Earth. The craft could point its heat-sensing telescope away from the sun, scan the icy blackness of space, and perhaps detect the glow of a dangerous asteroid on a collision course with Earth. Or a solar-sail spacecraft could be placed in orbit almost permanently above Earth's North or South Pole to monitor weather and climate. Solar sailing is a fantastic technology that is just in its infancy.

Think about the modern world we inhabit and the vast influence of exploration. The electronics or paper you're reading, the car you drive, the plane or train you ride, the food you eat, and the clothes you're wearing are all available to you because our ancestors figured out how to navigate the trackless ocean... the uncharted continents...the infinitude of space.

At the Planetary Society, our mission is to advance space science and exploration. Most people on Earth live day to day and night to night without thinking too much about space—but when we do, we can accomplish great things. By inviting the world's citizens to play a role in LightSail missions—to advocate for science funding, attend Planetary Society events, subscribe to launch updates—we give them a chance to be part of the future, to democratize space, and to help us all gain an important new perspective of the cosmos and our place within it. To the stars!

Mechanical engineer **Bill Nye** is CEO of the Planetary Society and an on-air expert on National Geographic's series *MARS* (season two premieres November 12). He is host of *Bill Nye Saves the World* on Netflix and a best-selling author whose book *Everything All at Once* is out in paperback this month. His Emmy Award–winning program *Bill Nye the Science Guy* helped introduce the millennial generation to science and engineering.



It Keeps Going...

As LightSail 2 prepares to go into Earth orbit, here's an update on a veteran of that circuit. Vanguard 1 (left) was the first solar-powered satellite when the U.S. vaulted it into orbit on March 17, 1958. It stopped transmitting in 1964—but more than 60 years after launch, it's still orbiting. That makes Vanguard 1 the oldest artificial satellite in space. So far it has circled Earth roughly 239,000 times, says NASA's David Williams, and "most estimates have the orbit lasting for hundreds of years."

PHOTO: NASA GLENN RESEARCH CENTER

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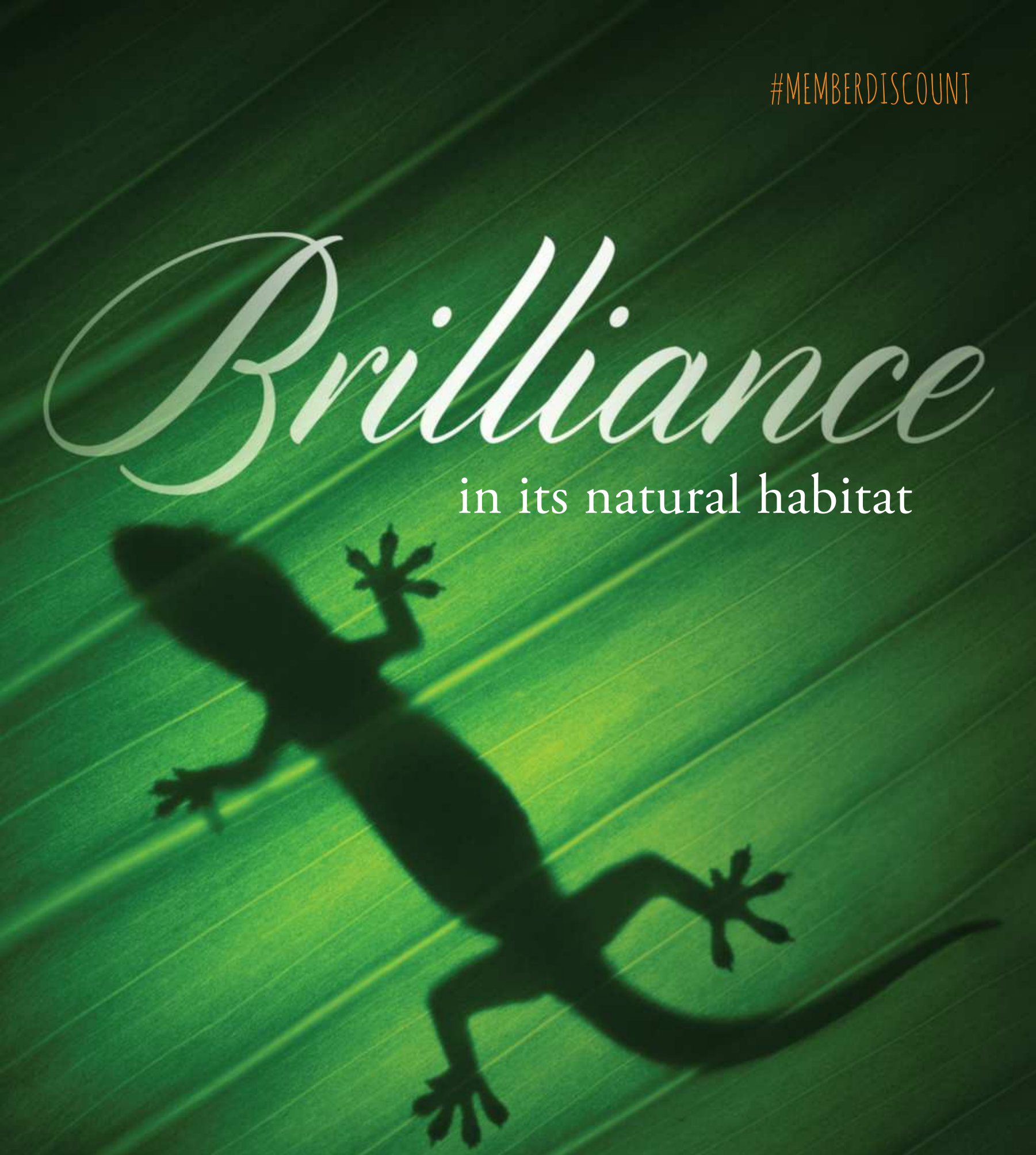
Brilliance

in its natural habitat



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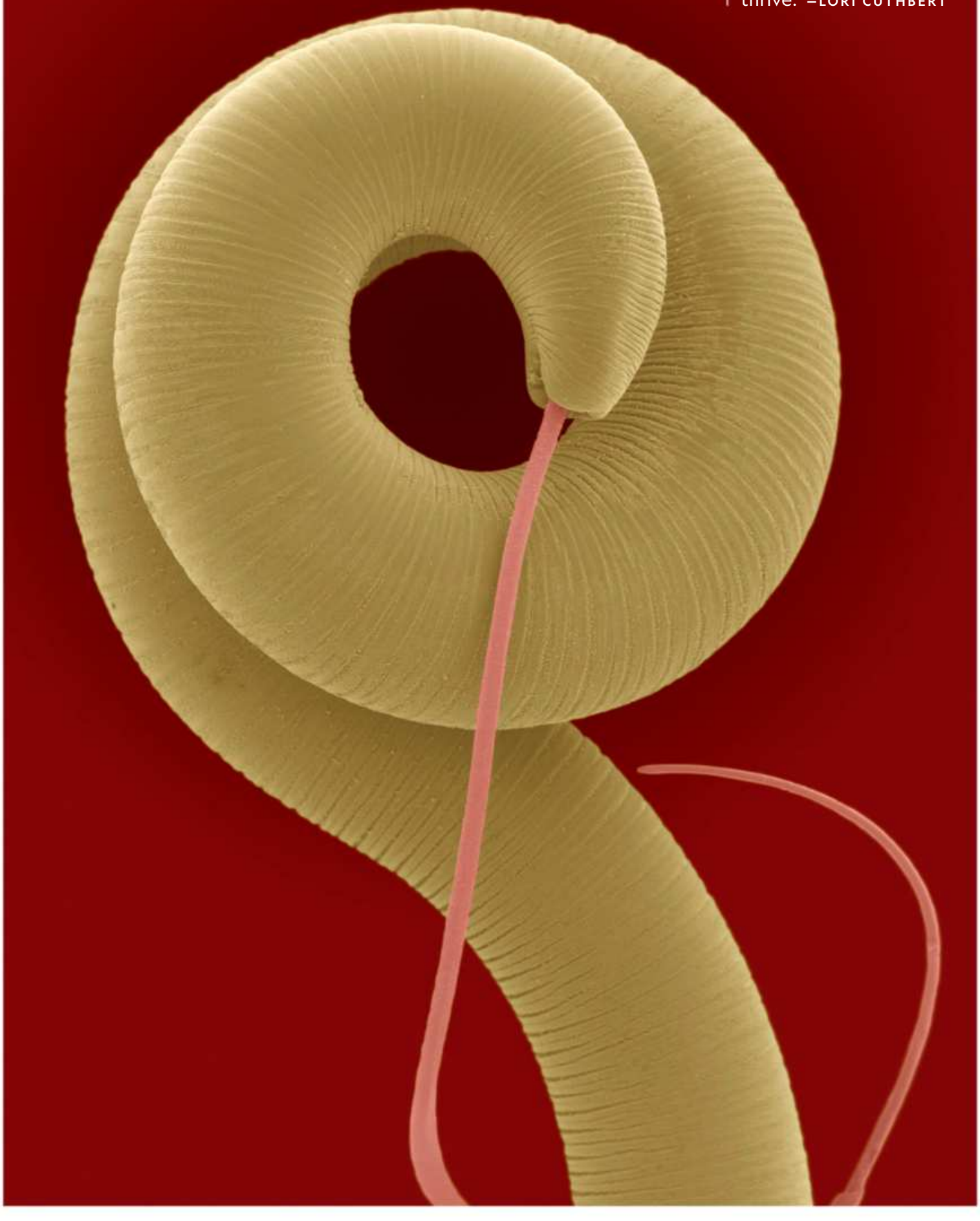
AS THE WORM TURNS

PHOTOGRAPH BY **DENNIS KUNKEL**

Positive Parasite
In less developed nations this helminth lives in human intestines—helpfully, says a report in *Science*. The worm promotes a microbiota that reduces bacteria linked to inflammatory bowel disease and other illnesses. Without the worm, bad bacteria can thrive. –LORI CUTHBERT



DENNIS KUNKEL MICROSCOPY, SCIENCE SOURCE (COLORED SCANNING ELECTRON MICROGRAPH)

Lost in the Medicare maze? There's still time to pick a plan.

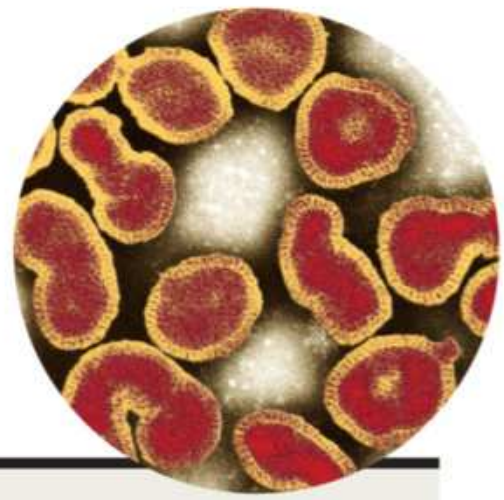
Medicare Open Enrollment ends December 7th. With helpful people, tools and plans — including the only Medicare plans with the AARP name — UnitedHealthcare® can help guide you through the confusion. Find the Medicare plan for you at **UHCmedicare.com** or call UnitedHealthcare at **1-855-826-1156,** TTY **711**.

AARP | Medicare Plans from UnitedHealthcare

DISPATCHES
FROM THE FRONT LINES
OF SCIENCE
AND INNOVATION

Lost in Transcription

The flu's genes are written in RNA, a chemical code like DNA but harder to read. To simplify, scientists can "rewrite" RNA into DNA—but they lose information in the process. Now there's a way to read flu genes directly: When RNA is passed through a tiny pore in an electrified membrane, resistance in the current helps identify the molecules and genes. – THERESA MACHEMER



ANIMALS

Last Rites for Crows

Crows are one of the few animals known to react strongly when one of their own dies, says researcher Kaeli Swift of the University of Washington. After a death, the flock gathers and may caw loudly, she says; it seems to be a way for them to learn about dangers they should avoid. Most don't get too close to their dead peer—unless it's breeding season, when hormones can affect their behavior.

—LORI CUTHBERT

ANIMALS

DOLPHINS' WHISTLES IDENTIFY THEIR PALS

DISTINCT 'NAMES' HELP TRACK RELATIONSHIPS

In the animal kingdom it's common for creatures in the same social circles to adopt similar calls. For years researchers assumed dolphins did the same. But as Stephanie King, a biologist at the University of Western Australia, spent time recording male bottlenose dolphin vocalizations in Shark Bay, she realized that individuals were using unique whistles, even within tight-knit groups. King deduced in a recent study that these calling cards, or "names," help dolphins keep track of "who their friends are, who are their friends' friends, and who are their competitors," she says. Next King will use these calls to learn how male dolphins form and maintain individual social relationships. A lot of this feels familiar to her. "There are a number of striking similarities between human and dolphin societies," she says. —NINA STROCHLIC

PHOTOS (FROM TOP): GOPAL MURTI, GETTY IMAGES; RALPH LEE HOPKINS; JOEL SARTORE, NATIONAL GEOGRAPHIC PHOTO ARK, GEORGE MIKSCH SUTTON AVIAN RESEARCH CENTER

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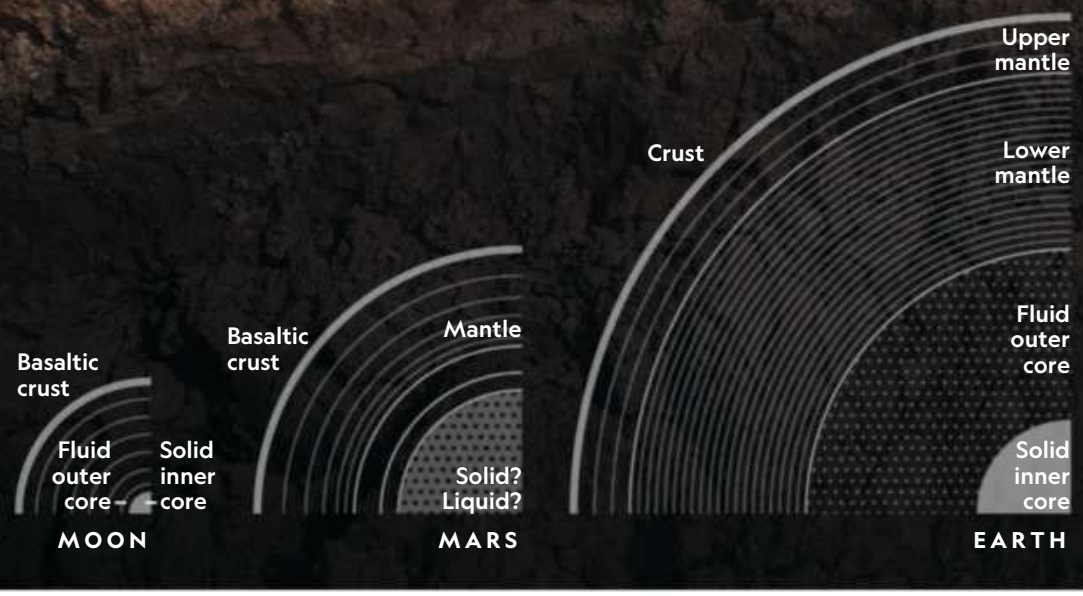
NATIONAL GEOGRAPHIC | VOL. 234 NO. 5

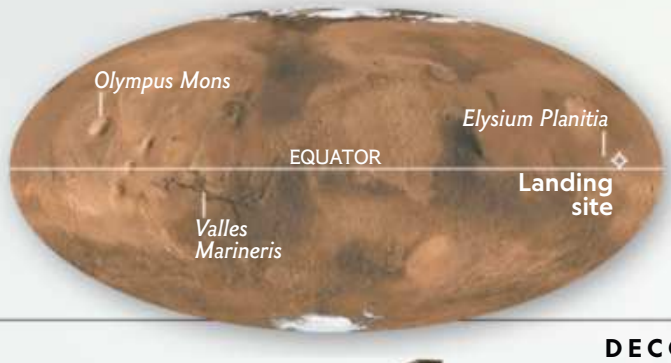
TAKING THE PULSE OF THE RED PLANET

NASA'S INSIGHT LANDER IS EXPECTED to set down along the sunny equator of Mars in late November. Its mission: Study Mars's ancient interior, a task that might shed some light on our own planet. That's because the same plate tectonics that give Earth its mountain ranges—and the conditions for life itself—have over eons transformed our ancient geology. Mars, on the other hand, has had a comparatively uneventful past three billion years, likely because it's too small to produce the energy for history-erasing tectonic shifts. So it might still hold clues to how rocky worlds, like ours, first formed and evolved.

Powering up
Two solar panels, large enough to run the remotely operated craft during a dust storm, unfold just after landing.



CORE QUESTIONS
Using instruments that measure **seismic activity, wobble,** and **internal heat,** the lander seeks to find out what makes up the core of Mars.



PLACE Elysium Planitia

LOCATION Mars

DISTINCTION The landing site is ideal because of its flat surface and low elevation. The site also gets enough light daily to power the lander and keep its electronics from freezing.

DECODER

BY **JASON TREAT**

Robotic arm

Radio transmitters

Solar panel

Prepping for exploration
A robotic arm with a mechanical hand and camera places a seismograph and a heat probe on the Martian surface.

Heat probe

Seismograph

1

Seismic activity
A seismometer will gauge vibrations from meteor impacts and "Marsquakes" caused by shifting rock. This could help determine the depth and composition of the crust, mantle, and core.

2

Wobble
Measuring the reflection of a radio signal sent from Earth to the lander will reveal the rotation of Mars's axis (precession) and the oscillations in that rotation (nutation), within four inches.

If Mars has a liquid core, its nutation will be more pronounced.

3

Internal heat
A probe will burrow into the soil to measure Mars's interior temperature. This could yield information on how heat flows inside Mars and why some rocky planets evolve plate tectonics and others do not.

16 feet below surface

ART: TOMÁŠ MÜLLER. MAP: MATTHEW W. CHWASTYK, NGM STAFF. SOURCE: BRUCE BANERDT, NASA

GENIUS

ABIGAIL ALLWOOD

BY **RACHEL HARTIGAN SHEA** PHOTOGRAPH BY **EMILY SHUR**

If there's ever been life on Mars, she could be the one to find it.

To discover the earliest signs of life on Earth, astrobiologist Abigail Allwood trekked to an isolated Australian desert. Now she's searching for signs of life from a distance, on a planet where she will probably never go.

Allwood works at the Jet Propulsion Laboratory and is a principal investigator for the Mars 2020 rover mission—the first mission, she says, with "the primary objective of searching for evidence of past life on Mars." Allwood's job is to examine the chemical composition of the red planet for evidence of ancient microbes.

For that she designed the planetary instrument for X-ray lithochemistry, PIXL for short. It looks like "a storm trooper's lunch box," she says, but underneath the white cover is the "most complicated instrument ever sent to the surface of another planet." Mounted on the arm of the rover, it will position itself with three pairs of legs, then move across the Martian surface in tiny 100-micron-size steps. As it proceeds, it will analyze the chemical makeup of different areas, mapping the elements distributed there.

Allwood hesitates to say what exactly she hopes to discover: "If you go with preconceived notions of what you need to find, then you'll be blind to what is there." But she is optimistic. "The chances of finding something on Mars that's *interesting* are high," she says. "We will have the ability to figure out what it is, one way or another."


DR. ENRIC SALA CONDUCTS RESEARCH FOR PRISTINE SEAS, A PROJECT DEDICATED TO PROTECTING OUR OCEANS.
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NATIONAL GEOGRAPHIC

When a Friend Defies Death

BY **PETER GWIN**

ALEX HONNOLD PLANNED TO CLIMB YOSEMITE'S EL CAPITAN WITHOUT A ROPE. HIS FRIEND JIMMY CHIN WOULD FILM IT. BUT FIRST THEY HAD TO FIGURE OUT HOW TO TALK ABOUT IT.

WHEN YOU ARE JIMMY CHIN, you make a long list of rules for filming your friend Alex Honnold's historic attempt to climb Yosemite's El Capitan without using any ropes. First you will hire a team of world-class climber-cinematographers to rappel beside him as he climbs the nearly 3,000-foot granite face. No one is allowed to whisper, sneeze, drop a lens cap, dislodge a pebble—any of which might create the distraction that sends him hurtling to his death. Most important, no one is allowed to talk to Honnold about the epic climb, at least not directly. This is to avoid putting any pressure on him but also to keep from upsetting his precisely calibrated mind-set, a mixture of acute concentration, bulletproof confidence, and deep Zen calm. Instead of using the term "free soloing," which means climbing without ropes or safety gear, you use his preferred euphemism—"scrambling."

You follow these rules knowing that any notion of rules is contradictory to the very idea of free soloing, because in this ruthlessly unforgiving sport there really aren't any rules, at least no written ones. That's much of the point. Climbing without ropes is decidedly against all the rules, especially the rules of mountain safety, not to mention human logic. But if a free soloist falls, there is no denying the immutable, unyielding rule of gravity.

Some veteran climbers say there is no *if* a free soloist falls—only *when*. You can think of many who have fallen to their deaths, some you knew personally. And suddenly there it is: the vividly horrifying image of your friend flailing into the void.

But wait. That's exactly what you're *not* supposed to picture when your buddy is trying to do what some experts say is the most daring ascent ever attempted—what Honnold's friend and fellow elite

JIMMY CHIN TOOK THIS PHOTO OF ALEX HONNOLD AS HE NEARED THE TOP OF EL CAPITAN.

Chin and Honnold pose on El Capitan's summit moments after Honnold completed his historic free solo.

climber Tommy Caldwell called "the moon landing of free soloing."

Such thoughts looped in Chin's mind for more than a year as he and Elizabeth Chai Vasarhelyi, his wife and filmmaking partner, documented Honnold's efforts to make climbing history. (Spoiler alert: He makes it.) The film, aptly titled *Free Solo,* is in theaters now.

"To film a climber with both the physical and mental ability Alex has, combined with the desire to take on something so ambitious and scary," Chin says, "it's the project of a lifetime, no doubt."

Chin, 45, and Honnold, 33, first climbed together in 2009 as part of an expedition to Borneo to explore Low's Gully, one of the world's deepest slot canyons. Honnold had recently burst onto the climbing scene with a series of headline-grabbing free solos, including Yosemite's Half Dome. Chin remembers being struck by Honnold's boyish face and large brown eyes, which would inevitably earn him the nickname Bambi.

But Honnold's youthful appearance belies his most exceptional gift—an uncanny ability to control his fear and focus on perfectly executing the task at hand (never mind that the task is reaching for a fingertip of rock while clinging to a cliff 1,000 feet up). It's a gift that Chin shares in some measure. Three years before meeting Honnold, he climbed Mount Everest and skied down its icy, nearly vertical face.

After Borneo, the men started climbing together regularly, with Chin filming some of Honnold's free solos. "We built up a lot of trust," says Chin. "He trusted me to safely film him, and I trusted him to climb only what he felt good about and not to feel compelled to do rad stuff for the camera."

Meanwhile Honnold had been privately contemplating what it would take to free solo El Cap. "After Half Dome it seemed like the next obvious thing," Honnold says. "At the end of each season, I'd think I'd be ready to do it the next year, but then I'd look up at it and think, Whoa, that's still too scary."

Finally, in late 2015, Honnold told Chin and Vasarhelyi he was ready, and they agreed to work together in secret on a film about the climb. "It was very important that the film would be about Alex's process," Chin says. "Whether it ended with him summiting El Cap or deciding not to go for it didn't matter. It was always about how do you even think about doing something so mind-bending."

Honnold chose a route called Freerider, one that often takes skilled climbers using ropes multiple days to ascend. He set about perfecting a hand-by-hand, foot-by-foot choreography up the famous cliff. Meanwhile Chin hired a crew of hard-core Yosemite climbers and began planning the extensive logistics.

Each practice session required many hours of preparation. Chin and the crew would speed climb an easy route up the east side of El Cap ahead of Honnold, lugging hundreds of pounds of cameras, ropes, and supplies. Then they'd rappel down Freerider and use a type of hand winch to keep pace with him as he climbed. "We all got in the best shape of our lives," Chin says. But at the end of each marathon day, the mental loop of what-ifs would play: "Not a day went by that I didn't think about the worst."

Around 5 p.m. on June 2, 2017, feeling that he was at his peak, Honnold asked Chin if the team could be ready to shoot the next day. "I think I'll go scrambling," he said. Chin nodded, acting like it was no big deal: "My mind was racing with all the things we needed to put in place before it got dark, but I didn't want to upset his mind-set, so I hung out with him for a while." Finally Chin told Honnold he'd see him in the morning and walked slowly until he was out of his friend's line of sight.

Then Chin ran like hell. He jumped on the crew's walkie-talkie channel and, using Honnold's code name, alerted the team to what was about to happen. "Bambi is going for it! Repeat: Bambi is going for it!"

Shooting high

During the climb Honnold averaged a blistering 100 vertical feet every seven and a half minutes. To capture each move, Chin and the crew rappelled to key spots along the route. In the diciest sections, they set up remote cameras to avoid disrupting Honnold's concentration.

PHOTO: SAMUEL CROSSLEY. ART: DAISY CHUNG, NGM STAFF
SOURCES: JIMMY CHIN; CINETIC MEDIA

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‘PRESERVING SAGEBRUSH FOR GROUSE WOULD HELP OTHER ANIMALS, BUT IT MIGHT PROVE COSTLY TO RANCHERS, MINERS, OIL AND GAS DEVELOPERS, AND REAL ESTATE BROKERS.’

BATTLE FOR THE AMERICAN WEST

BY **HANNAH NORDHAUS**

PHOTOGRAPHS BY **AARON HUEY**

THE NEW PUSH TO CUT BACK PROTECTED LANDS IS FUELING A DISPUTE ROOTED IN OUR HISTORY AND CULTURE. THE QUESTION: **WHOSE LAND IS IT?**

Arch Canyon is still protected within Bears Ears National Monument, but other canyons and thousands of Native American archaeological sites now lie outside the monument's newly reduced—and still contested—borders. The monument is named after the twin buttes on the horizon, which are held sacred by local tribes.

PREVIOUS PHOTO

In December 2017, days before President Donald Trump issued a proclamation shrinking the 1.35-million-acre monument by 85 percent, some 5,000 demonstrators—including Hopi-Chemehuevi activist Carl Moore—protested the move at the Utah statehouse in Salt Lake City.

One treasure still inside the Bears Ears monument is Procession Panel, a nearly 23-foot-long rock carving, or petroglyph, on Comb Ridge. At least 1,000 years old, it depicts a ceremonial gathering of some 190 humanlike forms converging from four directions. A succession of prehistoric cultures occupied the mesas and canyons of southern Utah for more than 12,000 years.

THREATENED HISTORY

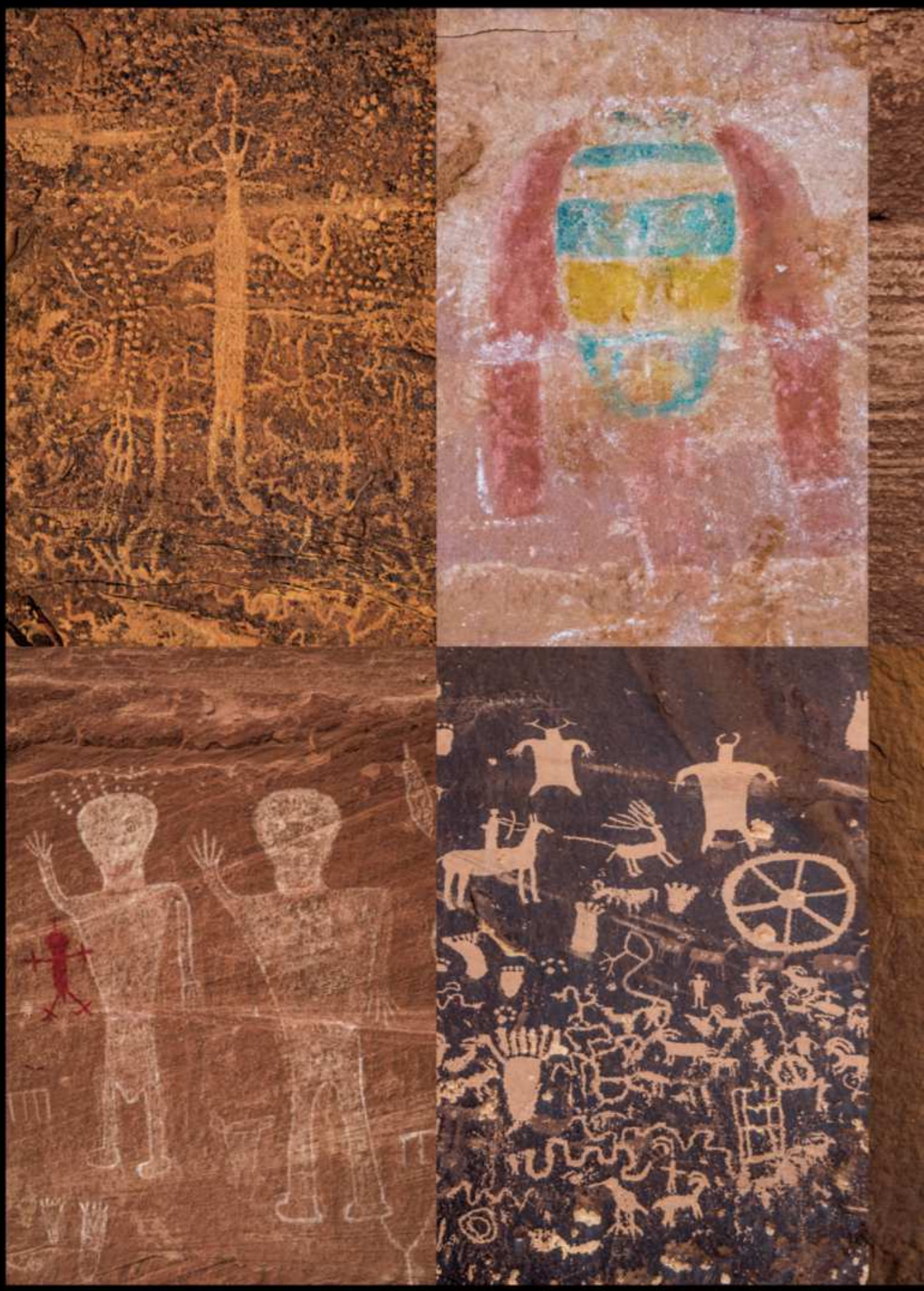
Petroglyphs and pictographs—images carved and painted onto rock—bear witness to the long and abiding connection of Native Americans to Bears Ears. The images here span millennia. They were made by nomadic hunter-gatherers of the Archaic period, which ended with the adoption of agriculture by about 1500 B.C.; by the Basket-makers, the first sedentary farmers, between 500 B.C. and A.D. 750; by ancestral Pueblo people, who built large cliffside settlements but migrated out of the region at the end of the 13th century; and by Ute and Navajo, who moved in later from the north and remain there today. Archaeologists have barely begun to interpret the enigmatic and irreplaceable art of the Bears Ears region. Isolation once protected it, but the recent influx of visitors has subjected some works to damage: graffiti, bullet holes, and even wholesale removal by looters armed with rock saws.

TOP ROW

The first panel, which appears to show a human figure, likely dates to the Archaic period, between 6000 and 2000 B.C. The other four, from the colorful mask to the bird, were made by Basketmakers—a name given by archaeologists to a people who also created finely crafted baskets.

BOTTOM ROW

The first panel (a detail from a large pictograph created over many centuries) and the third panel were probably made before A.D. 1300 by Pueblo people. Newspaper Rock (second panel) is called Tse' Hone in the Navajo language—"rock that tells a story." Located at the north end of the Bears Ears monument, it's a 200-square-foot rock face inscribed with hundreds of petroglyphs dating from 2,000 years ago through the early 20th century. The horse and rider (fourth panel) were probably inscribed by Ute, who moved into the region after about 1400, as did the Navajo and the Paiute. The last image is a Navajo rock carving. It's one of only a few known images of a Navajo Yeibichai—a masked, supernatural dancer.








Deep in a box canyon in Utah, in the heart of the fractured land known as Bears Ears National Monument, there is a cave—a swooping, mineral-streaked alcove in a sandstone cliff.

During Moab Jeep Jamboree USA, held every October, traffic on the Cliff-hanger Trail near Moab, Utah, can grind to a halt. The tourist crush unnerves locals on both sides of the national monuments debate, many of whom fear their own quiet rural towns will become another Moab.

In December 1893 a rancher-explorer named Richard Wetherill pushed his way through dense reeds and discovered inside that alcove a stacked-stone ruin where a prehistoric group of Native Americans once lived. He named the site Cave Seven. Some would later condemn him as a vandal and a looter—but Cave Seven proved to be one of the most important finds in the archaeology of the American Southwest.

It's easier to get there today than it was in Wetherill's era, but it's not easy. You bump along a dirt road that twists long miles through arroyos and canyons, past jagged crags and sandstone domes. Then you are on foot. You clamber through a dry watercourse clogged with bitterbrush and poison ivy; you sidle along a rock ledge. Look up: A dissolving jet contrail is the only sign of the time in which we live. Look down: What seem like stones at your feet are in fact remnants of cooking vessels. Such relics are everywhere, if you know how to look: A saltbush-covered mound conceals a ceremonial kiva; a subtle line in the earth marks a road connecting ancient villages. All around is evidence of things made, laid, and lived in centuries ago.

Wetherill excavated the surface ruin at Cave Seven, selling the artifacts to museums and collectors, leaving only a bit of masonry wall and smoke smudges. Then he kept digging. He had recently learned the novel concept of archaeological stratigraphy: the idea that prehistory is recorded in successive layers of sediment. Earlier remains lie beneath later ones—ruins under ruins, cultures under cultures. At Cave Seven, Wetherill found below the visible ruins a burial site that predated them by hundreds of

years. He dug up 98 skeletons from a previously unknown Basketmaker society. Deep in this forgotten canyon, deep in time, one culture had given way to another.

Bears Ears National Monument is now a battleground in another collision of cultures. Across the American West, from the desert canyons of Utah to the towering conifers of the Pacific Northwest, and in the mountains and sagebrush basins between, Americans are engaged in bitter disputes over public lands. Nowhere has the battle been fiercer than around national monuments, particularly Bears Ears, which then President Barack Obama created in December 2016.

Last December, President Donald Trump reduced the 1.35-million-acre monument by 85 percent and divided it into two smaller units, Indian Creek and Shash Jáa. He cut nearby Grand Staircase-Escalante National Monument by 46 percent. Interior Secretary Ryan Zinke also recommended shrinking other monuments, including Cascade Siskiyou in Oregon. He declined to be interviewed.

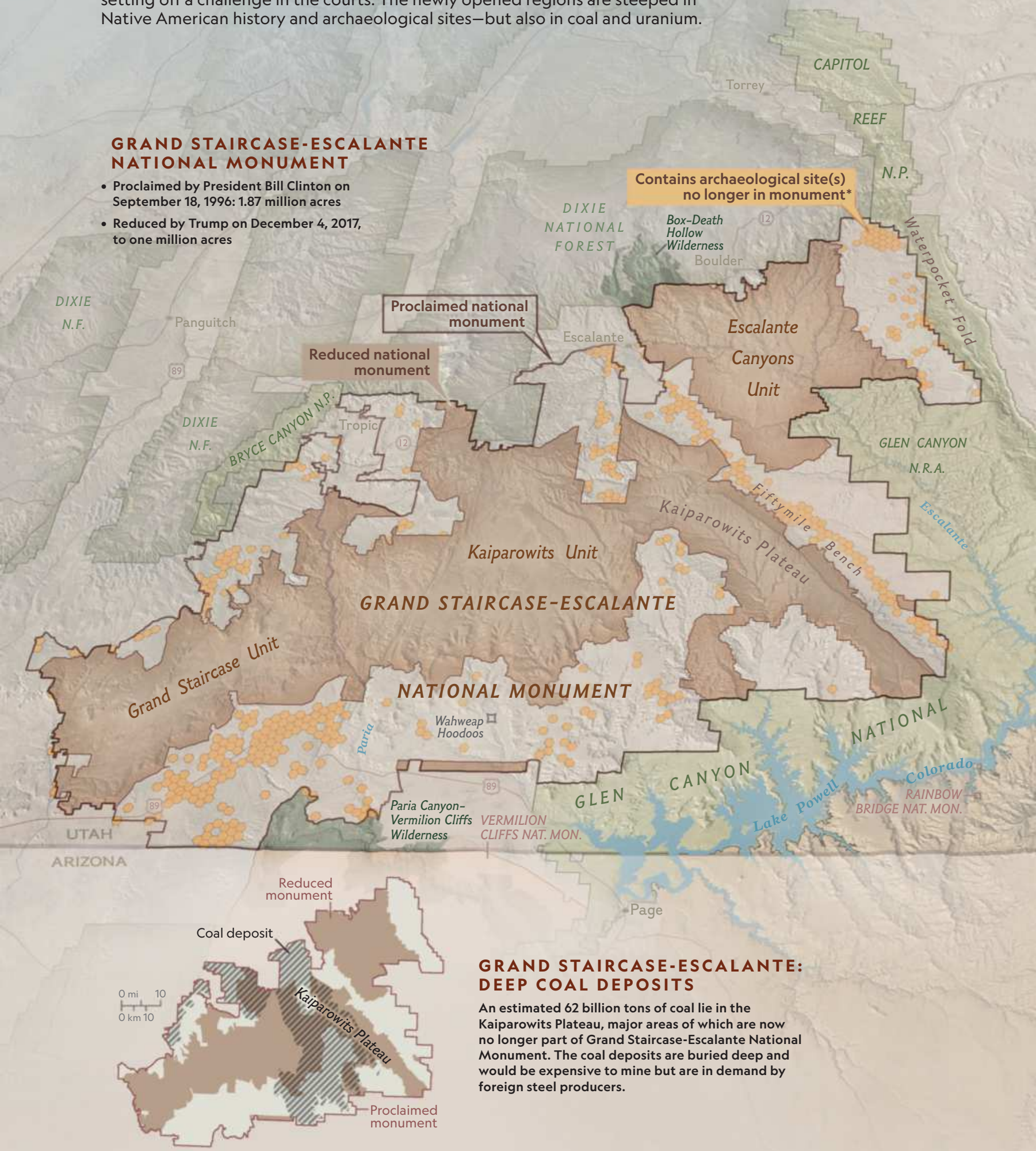
When Congress passed the Antiquities Act in 1906, authorizing the creation of such monuments, it was partly in reaction to the theft of Native American artifacts by people like Wetherill. The law gives presidents broad discretion to protect "historic landmarks…and other objects of historic or scientific interest" on federal land. Designating a monument requires no input from Congress. "A president could literally scratch something out on a bar napkin," says University of Colorado law professor Charles Wilkinson. There is no language in the law, however, granting subsequent presidents the power

A Monumental Challenge

Two national monuments in Utah, Bears Ears and Grand Staircase-Escalante, are treasured by many but are also politically contested. In 2017 President Donald Trump ordered the monuments shrunk by approximately 85 percent and 46 percent, respectively, paving the way for resource extraction and setting off a challenge in the courts. The newly opened regions are steeped in Native American history and archaeological sites—but also in coal and uranium.

GRAND STAIRCASE-ESCALANTE NATIONAL MONUMENT

- **Proclaimed by President Bill Clinton on September 18, 1996: 1.87 million acres**
- **Reduced by Trump on December 4, 2017, to one million acres**



GRAND STAIRCASE-ESCALANTE: DEEP COAL DEPOSITS

An estimated 62 billion tons of coal lie in the Kaiparowits Plateau, major areas of which are now no longer part of Grand Staircase-Escalante National Monument. The coal deposits are buried deep and would be expensive to mine but are in demand by foreign steel producers.

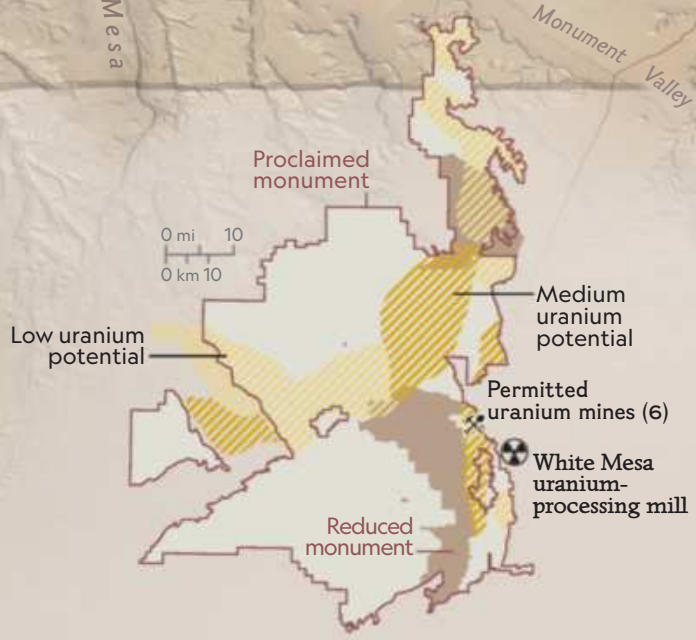
*FOR CLARITY, ARCHAEOLOGICAL SITES STILL PROTECTED WITHIN REDUCED MONUMENT EXTENTS ARE NOT SHOWN.

BEARS EARS NATIONAL MONUMENT

- **Proclaimed by President Barack Obama on December 28, 2016: 1.35 million acres**
- **Cut by Trump on December 4, 2017, by 85 percent to 201,876 acres**

Green
ARCHES N.P.
Moab
Cliffhanger Trail
MANTI-LA SAL N.F.
CANYONLANDS
GLEN CANYON N.R.A.
NATIONAL PARK
191
COLORADO
UTAH
Newspaper Rock
Indian Creek Unit
N
Colorado
Dark Canyon Wilderness
BEARS EARS
Monticello
MANTI-LA SAL NATIONAL FOREST
Hite
Lake Powell
RECREATION AREA
276
Bears Ears 9,058 ft 2,761 m
NATURAL BRIDGES NAT. MON.
Arch Canyon
Shash Jáa Unit
Blanding
Recapture Creek
95
191
Mancos Mesa
Bullfrog
Moqui Canyon
Grand Gulch
Cedar Mesa
WHITE MESA UNIT, UTE MOUNTAIN UTE RESERVATION
NATIONAL MONUMENT
Comb Ridge
262
162
San Juan
Valley of the Gods
Bluff
Lake Powell
Mexican Hat
Piute Mesa
NAVAJO NATION RESERVATION
163
Monument Valley
UTAH
ARIZONA

Scale varies in this perspective view. The distance from Page, Arizona, to Moab, Utah, is 155 miles (249 km).



BEARS EARS: URANIUM RESERVES

Oil and gas reserves in the newly opened territories around Bears Ears are estimated by geologists to have low potential. Uranium deposits, however, located near previously active mining sites in the western and northeastern regions of the opened territories, hold more promise.

MARTIN GAMACHE, NGM STAFF; KELSEY NOWAKOWSKI. SOURCES: BUREAU OF LAND MANAGEMENT; UTAH DIVISION OF STATE HISTORY; UTAH GEOLOGICAL SURVEY; SOUTHERN UTAH WILDERNESS ALLIANCE

to amend monuments created by their predecessors. In the days after Trump slashed the two Utah monuments, five lawsuits challenged the legality of the move. Those suits are pending too.

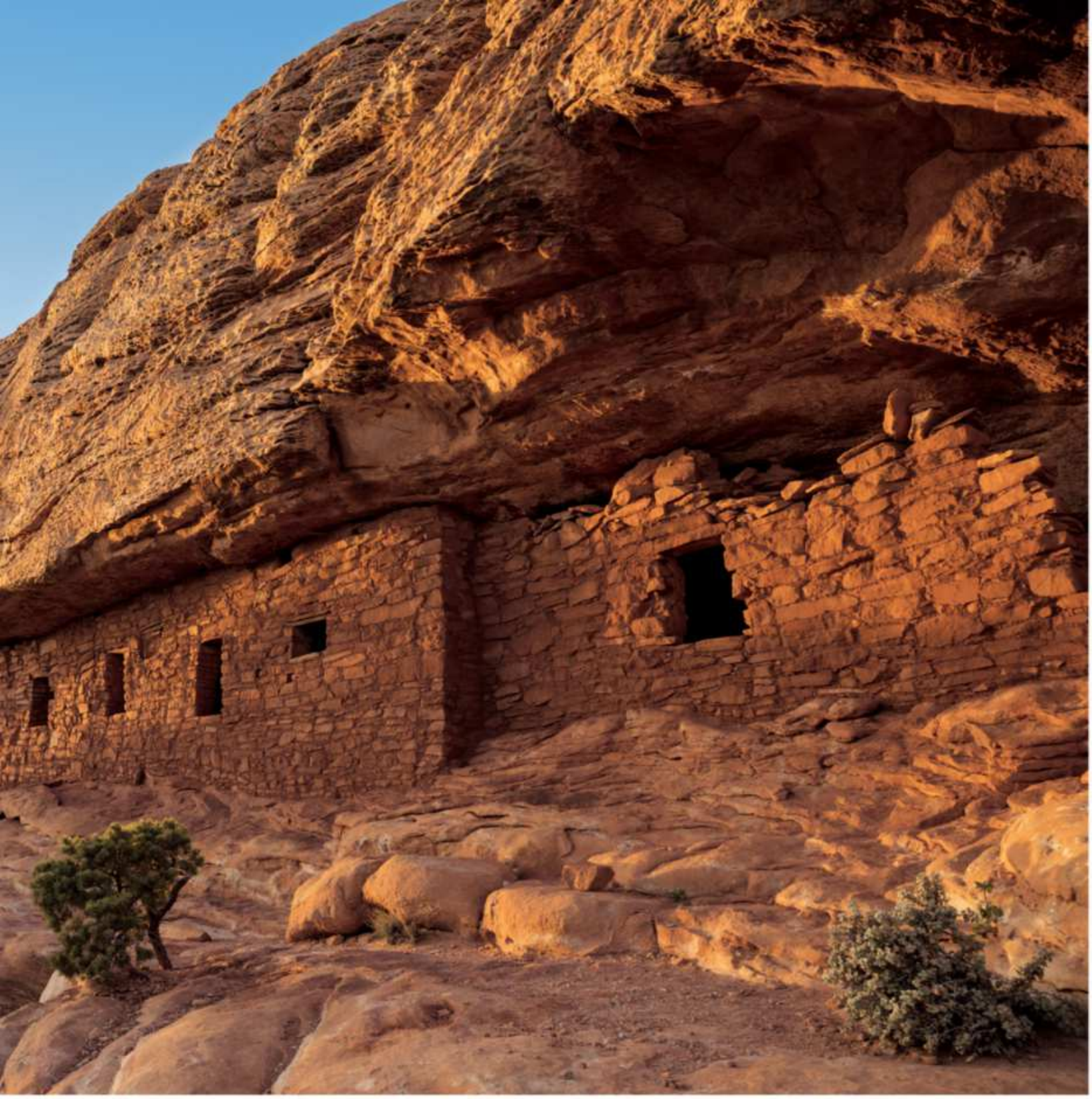
Republican presidents such as Theodore Roosevelt, who signed the Antiquities Act into law, have designated large monuments, but the number and acreage have grown dramatically in recent years, particularly under Democratic administrations. Like so much else, the struggle over western lands has become politically partisan. Trump's reductions were part of a larger campaign to reverse Obama's public land policies—by opening protected lands and waters to mining and drilling, by easing regulations, and by rolling back habitat protections for struggling species. (See related story on page 68.)

The reactions have fallen along predictable lines. Drillers and miners, loggers and ranchers, face off against hikers and bikers, climbers and conservationists. It's the Old West versus the New; the people whose livelihoods depend on extracting resources from the land versus those who visit and the businesses that serve them—and at Bears Ears, the Native Americans who were there first. Both sides cry "Land grab!" Both sides feel they have the one true answer to the question: What is the best and highest use of the land that, in principle, belongs to us all?

WESTERN LANDS HAVE BEEN A SUBJECT of intense dispute ever since the U.S. government seized them from native tribes. As the nation's rough edge expanded toward the Pacific in the 19th century, the transfer of "free land" to homesteaders, railroads, livestock barons, and mining syndicates was seen as part of building a nation. By the 1870s, however, that sense of the common good began to shift. In the upper Midwest, loggers had reduced magnificent forests to swampy fields of stumps. "People began using the phrase 'timber famine,'" says historian Patricia Nelson Limerick, and to worry that such rapid depletion of resources posed a long-term risk to the nation.

Out of that newfound sense of limits was born the notion of public land, managed in perpetuity by the federal government for the good of the nation. In 1872 President Ulysses S. Grant signed a bill creating Yellowstone National Park—the world's first. Congress empowered presidents to create forest reserves in 1891, and millions of acres of timberland are now managed by the U.S. Forest Service. In the 20th century the General

Ancestral Pueblo people built this defensive outpost high on a cliff sometime between A.D. 1100 and 1275. By the end of the 13th century, they left the region, driven out by an epochal drought that probably led to conflict over scarce food and water. Cultural clashes, more peaceful for the most part, continue to erupt across the American West today.



Land Office, which later became the Bureau of Land Management, slowly shifted its focus from selling "leftover" grasslands and desert to managing grazing and mineral extraction on those lands. Then as now, critics responded with outrage. "As nefarious a scheme as ever disgraced the nation," wrote foes of the forest reserves. "A fiendish and diabolical scheme," argued opponents of protecting the Grand Canyon.

That dynamic hasn't changed. The federal government still owns 575 million acres across the West—nearly half the total land of the 11 western states in the lower 48, including 63 percent of Utah and 80 percent of Nevada. Each action to protect or manage those lands has met with angry reaction. From the 1934 law that required leases for grazing, to the environmental laws of the 1960s and '70s, to protections for endangered species, Westerners have responded with legal action and sometimes violent resistance. They've planted bombs and summoned horse-riding, flag-waving, gun-toting protesters.

Nevada rancher Cliven Bundy and his sons typify that rebellious spirit. In 2014 the Bundys and their supporters held off federal agents seeking to impound cattle that the family had grazed on federal land for more than 20 years without paying fees. In 2016 Bundy's sons traveled from Nevada to Oregon to occupy the headquarters of Malheur National Wildlife Refuge after two Oregon ranchers who had clashed with refuge managers were imprisoned for arson. Trump recently pardoned the convicted ranchers.

By now it's a familiar story. The government

changes the rules or resolves finally to enforce them; tensions build and explode across the jigsaw ridges of the American West. "It's not unlike when they adapt Shakespeare for modern settings," Limerick says. "The script is the same, but Lear is wearing a business suit."

ON A BLAZING AFTERNOON in July 2017, a fashionably rugged mob descended on the Utah statehouse in Salt Lake City. They had begun a mile away at the convention center, where the Outdoor Industry Association was holding its summer show of recreation gear—backpacks, tents, portable espresso makers—for the last time in Salt Lake. Frustrated by Utah legislators' unrelenting opposition to the Bears Ears monument, the trade group had decided to move its lucrative gatherings to Colorado.

Wearing river sandals, eco-sloganed trucker hats, crocheted bear ears, and bald eagle costumes, the group marched past the Mormon archives and temple, singing and chanting ("Get Your Tiny Hands Off Our Public Lands!") and waving signs ("Speak Loud for Quiet Places"). Among the speakers who addressed the crowd was Northern Ute councilman Shaun Chapoose—on this issue the West's oldest inhabitants had allied with its newest. "Our lands were taken," Chapoose said. "Now yours are too."

The Bears Ears monument, named for twin buttes that jut above Cedar Mesa, owes its origin to an unprecedented coalition of local tribes. The original monument was estimated to include more than 100,000 ancient sites—cliff dwellings, kivas, great houses, and burial sites like Cave Seven. All were built by peoples who lived in the region for millennia but then departed at the end of the 13th century, driven out by drought and conflict.

Today their Hopi, Zuni, and Pueblo descendants still consider the region their ancestral home, as do the Navajo, Ute, Paiute, and Apache who moved into southern Utah and Colorado after the early Pueblo left. For years native leaders negotiated with local, state, and federal officials, seeking a legislative compromise on how the land should be managed. As the effort foundered in Congress, tribal and conservation groups pushed Obama to designate a monument before he left office.

The urgency wasn't merely political. The area's arid climate and profound isolation had long helped protect its archaeological

Just outside Bluff, Utah, on the edge of the Bears Ears monument, Apache dancers honor Navajo elders by performing a crown dance. The fight for the monument brought together dozens of tribes. "To Native Americans, natural resources are a gift," says Navajo activist Willie Grayeyes. "When you receive a gift, what do you do? Do you throw it away? No, you put it in a safe place and cherish it."

treasures—the rock art, potsherds, and tools, the human remains, the thumb-size corncobs. But our era of geotagged photos has made it easy to locate obscure sites. In the decade before the monument was created, visits to the area surged.

With rising and unregulated visitation has come more damage: tourists pocketing potsherds, campfires burning wood from century-old Native American shelters, graffiti on rock art, off-road vehicles blasting through burial grounds. “The strategy of leaving it alone and trying to keep it a secret is unsustainable,” says Josh Ewing, executive director of Friends of Cedar Mesa, a conservation group.

Nor are heedless vacationers the only threat. Wetherill’s discoveries launched a tradition of organized pothunting by white settlers. “The trashing started in the 1890s,” says Wilkinson, an adviser to the tribes who petitioned for the monument. “Pots were selling in London, Berlin. And skeletons—skeletons! It was carnage.”

Although the Antiquities Act outlawed collecting artifacts without a special permit on public land, even if it isn’t a monument, the desecration continued. In 1986 federal agents seized hundreds of illegal artifacts in Blanding, a town of 3,700 near Bears Ears; in 2009 the feds descended again, arresting 26, including two county commissioners and a beloved local doctor, who killed himself the next day. For many in Blanding, the raid screamed federal overreach; for native communities it only proved that existing safeguards hadn’t worked. “It got people thinking about how to protect all these ruins,” says Gavin Noyes,

"It is a diverse, iconic, some say spiritual landscape," says rancher Matt Redd. His family sold their 5,247-acre ranch to the Nature Conservancy in 1997, and it's now the largest private tract inside Bears Ears. Redd still runs the cattle as part of research on how to manage land in a changing climate.

Sandy Johnson fills his water truck on federal land cut from the Bears Ears monument. A fifth-generation rancher, he runs livestock on 300,000 acres of mostly public land—and worries about government regulations. "We don't need that monument," he says. "The land needs to be left alone so everybody can use it."

director of Utah Diné Bikéyah, a tribal nonprofit.

Mary Jane Yazzie sits on its board. A petite woman with short hair and long silver earrings, she is one of the last fluent speakers of the Ute language. The Ute Mountain Ute reservation near Blanding is cluttered with artifacts of modernity: pickup trucks, generators, satellite dishes. But the view from behind Yazzie's house is ageless. To the west lie the Bears Ears buttes, held sacred by Ute and Navajo; to the south the land drops toward Comb Ridge, an 80-mile wall of sandstone that, in Navajo tradition, forms the Earth's backbone.

"The land belonged to our grandfathers," Yazzie says. "They went hunting. The women gathered herbs, nuts, berries.

"We're tied to the land as if the land tied us to it: There's no way we're going to get away from it until we're no longer on the Earth."

THE TRIBE'S MORMON NEIGHBORS have their own deep connection to the land and their own origin story, though it goes back only a few generations—to 1879, when some 250 Mormons spent six months blasting a road down a cliff and navigating a maze of canyons to reach a verdant plain along the San Juan River, where they built the town of Bluff. The river was prone to flooding, however. Most of the community eventually moved uphill to farm on the sagebrush plateau around Blanding, 25 miles north.

In Blanding you can see the Bears Ears from almost anywhere. Even adamant monument opponents express a deep affection for the federal land that surrounds the town. "I like public lands," says San Juan County commissioner and state legislature candidate Phil Lyman, a descendant of Mormon pioneers. "You hike for miles and miles and miles and don't ever stop to think, Am I trespassing?"

But he and other monument foes also believe the land can and should generate profit. "I would like to know there's the ability to speculate on energy in that area," Lyman says. There are lucrative oil and gas fields just outside the old monument but no producing wells inside, and the rugged, remote, and archaeologically sensitive terrain makes such efforts unaffordable—unless oil climbs back above, say, $100 a barrel. Trump's Interior Department consulted with energy interests in drawing the monument's new boundaries. "I suspect there's potential," says Lyman, who owns uranium claims.

In 2014 he led a rowdy group of protesters, including Bundy's sons, on a ride into Recapture Canyon, which had been closed to protect ancient sites. He was jailed for that. Federal land managers "have become very much the enemy," Lyman says. For generations, locals could cut trees and camp and drive their four-wheelers wherever they wanted. Environmental rules have restricted those freedoms, Lyman says.

Yet just as disturbing, to monument friends and foes alike, is the prospect of too much access.

"National monuments don't necessarily bring more protection. They bring more traffic," says Nicole Perkins, a librarian in Blanding. She cites the specter of Moab, the rollicking recreational mecca 75 miles to the north, where a four-lane neon strip hosts an unceasing parade of RVs, ATVs, and rafting rigs. No one wants that for Bears Ears. "I came here for the silence and the stars and the vistas," says Bluff hotel owner Jim Hook. Notoriety has filled his hotel—but stolen some of that silence from everyone.

IN THE SPRING OF 2016, as the Obama administration considered the petition to make Bears Ears a monument, Perkins attended a community meeting with Blanding resident Janet Wilcox. A teacher spoke, explaining that her family lived across the Colorado River in the town of Escalante. "They had lived through 20 years of a national monument," says Wilcox. "She said, 'You have got to wake up.' That's what got me involved."

Escalante, in the secluded heart of Grand Staircase-Escalante National Monument, is a long, sinuous drive from anywhere. Before the monument, it was a somnolent square mile of homes and farms with wide, empty streets and about 800 residents. A timber mill processed logs from the national forest above the valley. A hundred or so ranchers grazed cattle on the surrounding federal land.

President Bill Clinton created the monument as he campaigned for reelection in 1996. He cited its breathtaking scenery—cloud-shaped rock formations, elephant-humped ridges, whorled slot canyons plumbed by waterfalls. His administration had done the preparatory work in secret, knowing that local politicians would be furious. And fury there was: Grand Staircase-Escalante was, in many ways, the original sin that spawned the current backlash against the Antiquities Act. It covered nearly 3,000 square miles.

In the 22 years since, Escalante has served as

both inspiration and cautionary tale for other communities. Tourism attracted by the monument supports new hotels, restaurants, and guide services. The town has a new hardware store, a dentist, and a health clinic—before, a doctor saw patients once a week in the high school gym. It has a housing crunch and, in some sectors, a labor shortage. Electricians and plumbers are booked out for months.

Many of them work for "move-ins" such as Steve Roberts, a serial entrepreneur with thick-rimmed glasses who first visited after Clinton protected the area. "Escalante is magical," Roberts says. In 2004 he bought Escalante Outfitters, a busy restaurant–bookstore–camping-supply store. (He has since sold it.) That year he also started an arts festival. Visit in late September, and you're likely to see artists with umbrellas and easels painting blooming datura flowers or landscapes of white-rock immensity.

Some locals, however, believe the monument has hurt the region. After the designation in 1996, the government bought out coal leases on the Kaiparowits Plateau, inside the monument, and a planned coal mine never opened. Existing grazing leases were preserved and cattle numbers have remained steady, but ranchers complain that new environmental rules make it harder to prosper. The lumber mill, which struggled for years, closed for good in 2009.

"The natural resource jobs went away," says Drew Parkin, a resource manager who once worked at Grand Staircase-Escalante but came to oppose how the monument was managed. "In an environment like this, tourism jobs can't take their place—full-time jobs, with benefits, year-round." In winter the only restaurant open in the town of Escalante is a Subway in a gas station. High school enrollment has dropped by more than half; young families have left.

Those declines, though, reflect larger trends across the rural West. "People blame the monument for everything bad," Roberts says. Escalante's travails predate the monument: Its population peaked in 1940 at more than 1,100 residents, and by 1970 it bottomed out at just over 600. Overgrazing, which made ranching less profitable, was one factor. A coal mine would have brought new jobs, but for how long? The coal market is depressed.

Instead it's the New West economy that's bringing employment. "I could name 10 businesses someone could start tomorrow that would thrive here," says Blake Spalding, a wild-haired Buddhist restaurateur who co-owns Hell's Backbone Grill in nearby Boulder, Utah. Her restaurant and 6.5-acre organic farm support 50 seasonal employees. "Most of them make double the minimum wage," she says—albeit only from March to November.

Cutting the monument by nearly half, as Trump has done, is unlikely to jump-start the old economy—the coal is still too expensive to mine—but it has introduced uncertainty in the new one. "It's been 22 years now," says Spalding. "These gateway towns are full of people who made lives and families around the monument."

"To gamble with the new economy that has grown up around the monument is shockingly reckless," adds Nicole Croft of Grand Staircase Escalante Partners, a conservation group. In the years since the monument was created, Croft says, the move-ins had reached a kind of peace with the descendants of the Mormon pioneers. But Trump's cuts have rekindled old hostilities. "It snapped really fast," she says.

President Clinton's designation of Grand Staircase-Escalante in 1996 was the original sin that spawned the current backlash against the Antiquities Act.

BEFORE ANYONE MOVED IN and claimed the land—before natives, settlers, loggers, ranchers, second-home owners—there was the land itself. A thousand miles from Utah's desert canyons, on the Pacific Crest Trail in southern Oregon, Dave Willis is keenly aware of that fact.

A Pacific storm is blowing in, clouds boiling with moisture. Willis, who chairs the Soda Mountain Wilderness Council, has been advocating for this piece of the West—which now includes Cascade Siskiyou National Monument—for decades. At press time Trump hadn't acted to cut the monument. Willis lives in its heart, in a tumbledown trailer in a former logging town. Short and sturdy, with a ruddy, graying beard, he lost large parts of his hands and feet to frostbite years ago, climbing in Alaska. He rides the trails on horseback.

Cascade Siskiyou was the first national monument named specifically to protect the plants and animals that predate us all. Clinton carved the monument in June 2000 from a landscape of hazy timberlands and undulant chaparral. It covered 85,000 acres then, including 32,000 acres of private inholdings, and the range of elevations and life zones it spanned made it, says Willis, "a veritable Noah's ark of botanical diversity." There are hundreds of species of flowering plants. Chickadees, hummingbirds, gnatcatchers, spotted owls, all adapted to different ecologies, live here in close proximity.

The original monument was small and not particularly controversial. But in 2011 a group of scientists determined that, as humans encroached on nearby habitat and as climate change pushed species outside the monument, its current boundaries weren't sufficient. Heeding that argument, Obama doubled its size a week before he left office. Timber interests promptly sued, along with counties that had received timber revenue from land in the expansion area.

The resource economy in southern Oregon has been hurting for a long time. The number of timber jobs in the state has dropped from 15,000 to 5,000 over the past 40 years; a mere 385 remain in Jackson County, home to Cascade Siskiyou. County Commissioner Colleen Roberts grew up in nearby Klamath Falls. Her father worked in timber. "When I was in high school, that's what the boys did, and it was good money," she says. She opposes the monument expansion.

So does Lee Bradshaw, a third-generation rancher with an eagle nose and extravagant mustache. In a sun-baked meadow just outside the monument, he lays out a salt block and shouts for his cattle. The expansion preserved his grazing leases, but he's seen neighbors quit and worries he'll be regulated off the land. "I've never done nothing else but run cattle," he says. Some years he doesn't turn a profit; he gets health insurance through his wife, a nurse. "I never got in it for money. The only reason we do it is it's our heritage. I want this to go on to my kids."

To activists like Willis, heritage is no excuse. "What's the result on the land of those connections to the past?" Willis asks. "Ranchers pay $1.41 a month for cattle to poop in creeks, break down streambeds, and spread weeds. They are the lords and ladies of yesteryear."

Willis has his own preferred version of yesteryear: an old-growth grove that his group fought, successfully, to save from timber harvesting and include in the expanded monument. Red ribbons still droop from once doomed trees—ponderosa pines, lofty Douglas firs—as he rides into the heart of the grove. The wind rustles the high canopy; down below it is utterly still. Willis raises an arm toward a massive ponderosa.

"How old is this pine?" he asks. "Older than our nation." He looks at the canopy around him. "This, here, is a forest," he says. "And it's tragic and heartbreaking that there's so little of it left."

"OF WHAT AVAIL ARE FORTY FREEDOMS without a blank spot on the map?" the writer and conservationist Aldo Leopold once asked. Today, Willis says, "blank spots are having a rough go of it." Americans look at the same breathtaking western landscapes and see different things: irreplaceable forests and canyons, the great houses and gravesites of cultures past, the homes and heritage and livelihoods of today. As the blank spots dwindle, the visions collide. Everyone feels something cherished is being taken away.

The legal challenges to Trump's monument reductions in Utah may take years to resolve. But in August the administration proposed new management plans for the truncated monuments; its "preferred alternative" for lands removed from Grand Staircase-Escalante would open up nearly 660,000 acres to resource extraction. Mining interests are already staking claims. It's unclear whether mining can proceed before the president's legal authority to shrink monuments has been established. "I'm very concerned there's going to be irreparable harm here," says Croft, the Escalante conservationist.

Opposition to protecting western public lands has flared up ever since public lands were invented, yet the amount of protected land has—at least until now—steadily increased. Can any single presidential administration stand athwart history, demography, and economics in the West? Can it resist the new culture that—for better and worse—is supplanting the old one?

Some people hated setting aside the Grand Canyon, says Steve Roberts in Escalante. Now it's an iconic national park. "How do you quell all this resentment and hate?" Roberts asks. "That's easy. Wait three generations." □

Hannah Nordhaus wrote *American Ghost,* a history of her family in New Mexico. She lives in Colorado. **Aaron Huey** is creating 3D models of ancestral Pueblo sites in Bears Ears. He grew up in Wyoming.

The Wahweap Hoodoos are one of the geologic marvels excluded from Grand Staircase-Escalante National Monument since Trump cut it nearly in half. The monument has boosted tourism, but some locals believe it has hurt the old economy based on ranching, timber, and mining.

BATTLE FOR **THE AMERICAN WEST**

BY
Hannah Nordhaus

PHOTOGRAPHS BY
Charlie Hamilton James

SAVING THE SAGE GROUSE

This awkward, not-so-smart bird symbolizes the tension over land use and preservation in the West.

The sun rises in Wyoming on male sage grouse strutting their stuff, chests puffed, tails splayed. Their courting arenas, or leks, are clearings in the sagebrush.

"The sage is all things to these birds of the plains," Rachel Carson wrote. Sage grouse feed on the tough, drought-resistant shrub in winter, and in spring they return to the same leks to court and mate and nest under the sheltering branches. As sagebrush has retreated across the West, so have the grouse: Their population has declined by an estimated 90 percent.

At the Barney Ranch near Big Piney, Wyoming, ranch hands corral and brand young calves. Listing sage grouse under the Endangered Species Act—as some conservationists have urged—would place severe limits on ranching, oil and gas development, and other economic activities on western lands, both government owned and private.

To contain a wild blaze, a firefighter sets a backfire near Boise, Idaho, in August 2017. In parts of the West, overgrazing by sheep and cattle in the late 19th century greatly decreased native grasses and forbs that grow around sage-brush. That cleared the way for invasive cheat-grass and other species that are more prone to fire—and less palatable for young grouse.

The undulating, high-desert "sagebrush sea," the only place where sage grouse can survive, sprawls across 173 million acres of the American West. But the unbroken expanses the birds require are now fragmented by roads, fences, drill pads, transmission lines, and subdivisions. "There's just not enough habitat anymore," says Brian Rutledge of the Audubon Society.

Well before dawn, near the Little Snake River in southern Wyoming, Pat and Sharon O'Toole's pickup bounces up a broad, sage-covered valley, where the family has run livestock for five generations.

A prairie dog scans for predators in the Jonah Field in western Wyoming. The gas field was once prime habitat for sage grouse—as well as for prairie dogs, pronghorn, burrowing owls, and other animals that depend on sagebrush. Saving grouse habitat would help them all.

Pat turns off the headlights and rolls toward a clearing. Under a moon that's just past full, we make out dozens of white dots, hopping up and down on the dark plain. The sage grouse have been dancing all night.

As the morning light grows over the eastern mountains, the outlandish mating ritual comes into view. The knee-high males strut around, puffing their white-feathered chests and splaying their tails. They chase one another and spar in a flurry of beating wings, heaving chests, and loud thunking. Meanwhile the females—smaller birds with brindled gray feathers that blend with sage and soil—stand around looking bored. It's a ridiculous spectacle, and the human analogies are inescapable: singles bar, Venice Beach boardwalk, Senate hearing.

The greater sage grouse is "unquestionably the most comical-looking bird I have ever seen," ornithologist Charles Bendire noted in 1877. Back then there were millions of sage grouse across the American West. Native peoples and Anglo settlers alike hunted them for feathers and food. Camping in one Wyoming valley in the 1880s, naturalist George Bird Grinnell found it so crammed with grouse that it became a "moving mass of gray."

Such scenes are hard to find today. Less than 10 percent of the bird's original population remains, about half a million birds scattered across 11 western states and two Canadian provinces. Sage grouse need undisturbed sagebrush; the tough, drought-resistant shrub feeds the birds, especially in winter, and shelters

them and their nests. But sagebrush is in retreat everywhere. Massive overgrazing a century ago cleared the way for invasive grasses that now fuel devastating fires in the western part of the bird's range. Roads and subdivisions, transmission lines, farms, gas fields, and wind turbines—all disrupt what was once an unbroken sea of sage.

Preserving sagebrush for grouse would help other animals that depend on the same habitat, such as pronghorn, mule deer, pygmy rabbits, and burrowing owls. But it might prove costly to ranchers, miners, oil and gas developers, and real estate brokers. In 2015 then President Barack Obama's administration brokered what it hailed as a historic collaboration among those competing interests. Now President Donald Trump's administration is weakening provisions that steered oil and gas drilling away from areas that had been reserved for sage grouse.

It's the age-old battle between those who want to preserve western lands and those who want to extract a living from them—only in this case, the burden falls on a comical, knee-high bird. As the sage grouse goes, so goes the West.

ONE OF THE BIGGEST FACTORS in the grouse's decline these days may be the astonishing increase in natural gas production in places such as the Green River Basin, south of Pinedale, Wyoming. In 1984, when biologist John Dahlke first visited, the basin contained sagebrush, a few fence posts, some two-track roads, and not much else—except the largest known winter concentration of sage grouse. They would

lift from the sage in lumbering waves, Dahlke recalls: "The sky was full of them, bumping into each other, falling down."

That basin is now home to one of the most productive gas fields in the region. Called the Jonah Field, it's crisscrossed with roads and cluttered with chugging, groaning infrastructure: gas wells, drill rigs, pipelines, sage-camouflaged service huts. Nearly all of that is on federal land.

"It happened stunningly fast," says Dahlke, who works as a wildlife consultant in Pinedale. "From absolutely silent, just the wind or the hiss of snowfall hitting the ground, to an industrialized landscape."

The breakneck change has proved particularly hard on sage grouse because of their fidelity to ancestral mating and nesting grounds. Males return each spring to the same leks—clearings where they do their mating dances. Females usually nest within 500 yards or so of the previous year's nest. Their chicks settle nearby.

"Sage grouse are very poor pioneers," Dahlke says. Rather than set off for better habitat—which is more and more limited—they dance doggedly on and nest among the bulldozers and flaring gas wells. Most birds survive in the short term, Dahlke says, but "incremental impacts" take their toll. The number of leks has dwindled. "The enormous winter flocks are now gone from the Jonah Field," Dahlke says. "They are gone."

ONLY IN THE EARLY 1990S did scientists start to realize the extent of the sage grouse's decline across the West. In 1999 conservation groups filed the first petition requesting that the bird be protected under the Endangered Species Act. But for years the federal government, hamstrung by tight budgets and pressure from business interests, put off a reckoning. Listing sage grouse as endangered would sharply limit economic activity on the 173 million acres of public, state, and private land where sage grouse live.

But the threat of a listing motivated states to take action. In 2007 Wyoming, which houses more than a third of the remaining sage grouse and has an economy that depends on fossil fuel extraction, brought together a broad coalition—ranchers, industry representatives, conservation groups, land managers, and politicians—to create a policy to halt the bird's decline.

"We battled it out mightily," says Paul Ulrich, director of government affairs at Jonah Energy, which operates on the Jonah Field. "And then we put our interests aside and asked, 'What is best for Wyoming?'"

The group ultimately agreed to limit any development and restore disturbed areas within "core" grouse habitat—not including the Jonah Field, where the grouse population was already diminished—while allowing more intensive development elsewhere.

The Obama administration's $60 million federal plan was modeled on Wyoming's. No faction got everything it wanted. But, Ulrich says, "it's demonstrably working." Industry got certainty: The administration promised it wouldn't list sage grouse as endangered. Conservationists, says Brian Rutledge of the Audubon Society, got limits on development in important habitat. "Do we have issues?" Rutledge asks. "Of course. But we set standards and are measuring impacts. To me this is the future of conservation."

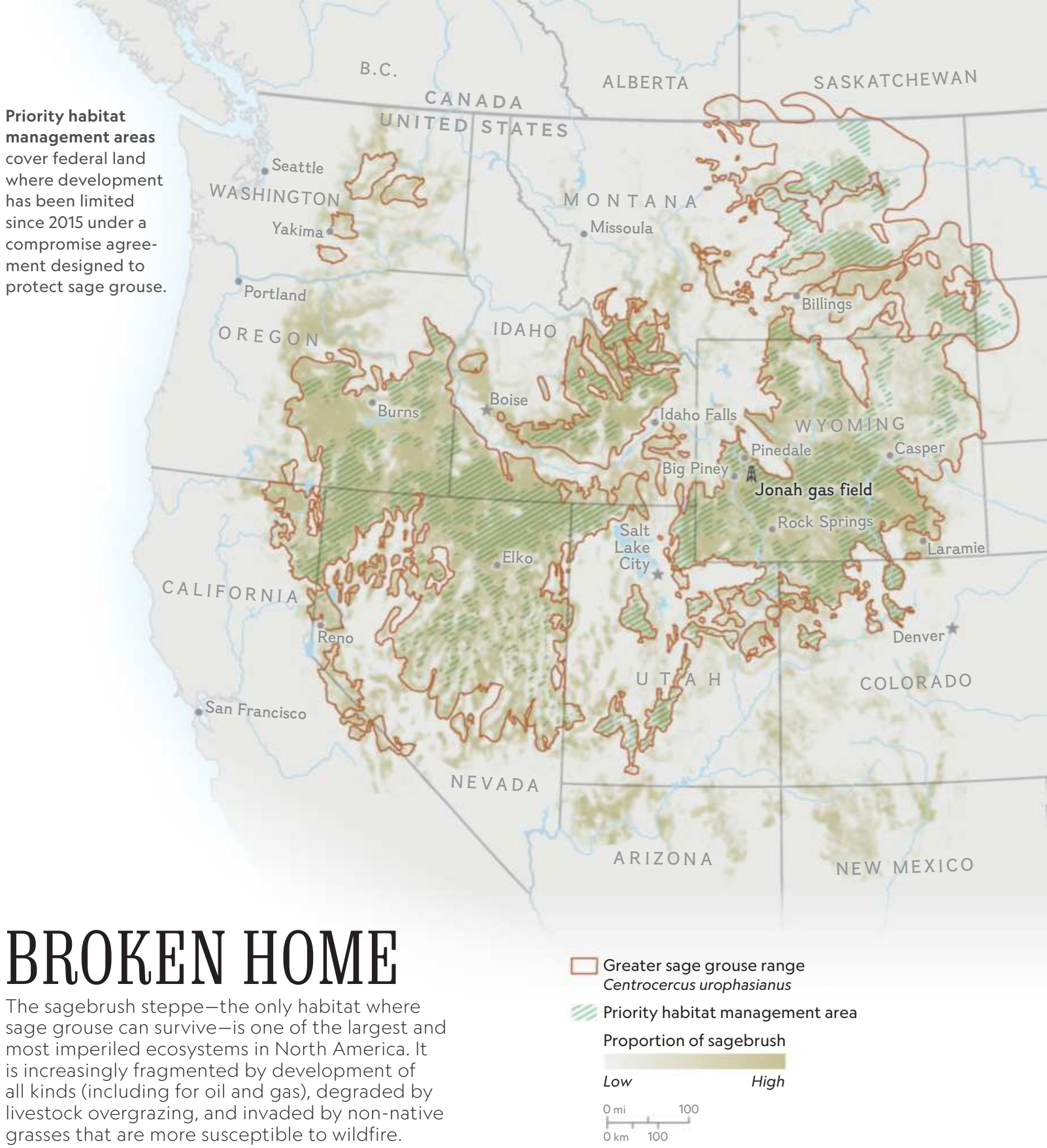
Not everyone agreed. Groups on left and right filed suit, arguing, respectively, that the plan would not adequately protect grouse or that the restrictions were "draconian." "The certainty of not being able to develop is not the kind of certainty we want," says Kathleen Sgamma of Western Energy Alliance, an industry group.

The Trump administration agrees: For the sake of energy independence and not "destroying local communities," as Interior Secretary Ryan Zinke put it, the Bureau of Land Management has proposed lifting some restrictions on development in key sage grouse habitat. Under another proposed policy, which could affect many species, the administration would allow regulators to consider not only the science but also the economic impact of listing species as endangered.

ON THE O'TOOLE RANCH, the sage grouse dance ends without romance. The females lurking on the edge of the lek finally choose. Most mate with the same male. A female turns and arches her wings, and the deed is done in a matter of seconds. The sun climbs higher, and the birds scatter back into the brush.

Before the endangered species petitions, Pat O'Toole says, "we never paid much attention to sage grouse. They were just part of the landscape, like deer." He participated in the state and federal negotiations and is generally happy with the results. The federal plan made funds available to maintain habitat both for the grouse and for his livestock. This particular area, which will

Priority habitat management areas cover federal land where development has been limited since 2015 under a compromise agreement designed to protect sage grouse.



BROKEN HOME

The sagebrush steppe—the only habitat where sage grouse can survive—is one of the largest and most imperiled ecosystems in North America. It is increasingly fragmented by development of all kinds (including for oil and gas), degraded by livestock overgrazing, and invaded by non-native grasses that are more susceptible to wildfire.

serve as a lambing ground later in the spring, is home to six grouse leks and countless other creatures—pronghorn, mule deer, bald and golden eagles. "It's an intact system," Pat says.

There are species—such as ravens, which now use oil rigs as perches to prey on sage grouse—that manage to flourish when their environment shifts. Sage grouse are not among them. They are supremely evolved to live in the harsh, silent American steppe, but they are birds of little brain. "They're not smart at all," Sharon O'Toole says. They run into fences, stand in the middle of busy roads.

Humans, like ravens, are more adaptable. We can learn to do things differently. That's what Audubon's Rutledge believes: That we can alter the behaviors that trap us in time-worn conflict and chest-puffing displays of political dominance in the West. He hopes that collaboration on sage grouse, if allowed to work, will provide a template for other conservation efforts.

"Everyone says you can't change this," he says. "And if I'm rational, probably not. But I don't think it's any excuse not to try." □

Charlie Hamilton James specializes in images of wildlife but admits the low-angle shot of the sage grouse was the hardest photo he's ever taken. "It took five weeks, a lot of coffee, and a pile of gear."

CLARE TRAINOR, NGM STAFF. SOURCES: BLM; USGS; USFWS

BY **TRACIE McMILLAN**

PHOTOGRAPHS BY **GRANT CORNETT**

MENU OF THE FUTURE

INSECTS, WEEDS & BLEEDING VEGGIE BURGERS

CRICKETS!
IN CHIPS, ENERGY BARS
& OTHER PROCESSED FOODS

If you're picturing insects in your future diet, trade that image of a tarantula-on-a-stick for one of a smoothie. "We're not going to replace meat with bugs," says Julie Lesnik, author of *Edible Insects and Human Evolution*. Insects can be an ingredient in animal feed or the processed foods we know: chips, protein bars, and smoothie powders. "It's bugs, but it's food," Lesnik says. "It can become an ingredient like anything else."

Peer into the future of what we eat, and you'll start wondering what could happen to our meals. As the world's population surpasses nine billion by mid-century, our food needs will grow by 50 percent. How do we meet them without mowing down more forests or expanding industrial agriculture, one of the most significant contributors to climate change? How do we maintain the health of our soil, so that crops can thrive?

These questions get into murky territory. But one thing is clear, says LinYee Yuan, editor of *Mold* magazine, which covers the future of food. "To feed nine billion people," she warns, "we're going to need all hands on deck."

Many of those hands likely will be trying to find new ways to produce protein as the environmental strain of industrial animal production becomes increasingly untenable. Livestock production represents about one-seventh of all human-made greenhouse gas emissions. Beef produced in concentrated feeding operations typically requires nearly eight times the water and 160 times the land per calorie as vegetables and grain. No wonder United Nations officials have been urging everyone to eat less beef—and new food companies are taking that edict seriously.

Among them is the purveyor of the Beyond Burger, a patty with beefy coloring from beets and protein from peas that is already available throughout the United States in about 10,000 grocery stores and at least as many restaurants. Its closest competitor sells the Impossible Burger, a plant-based patty that "bleeds" juice, thanks to a lab-made protein called heme. That burger is now sold in a thousand outlets in the United States and Hong Kong.

Other companies are seeking to industrialize meat production so thoroughly that no animals are necessary. Industry leaders compare the production of lab-grown meat to that used for beer, swapping fermenting grain for engineering animal cells in massive culture vats. "It will look a lot like a brewery," says Bruce Friedrich, executive director of the Good Food Institute, an industry group. And, just as beer

WHAT'S IN A BLEEDING VEGGIE BURGER?

The Impossible Burger (shown on pages 82-83) is made from wheat and potato proteins, coconut oil, and other ingredients, including yeast-derived heme, which makes it appear to bleed. Citing the environmental consequences of industrial animal production, the companies behind plant-based burgers argue that the problem is not meat, but meat from animals. "We believe we're sort of inventing meat," says Jessica Appelgren, with Impossible Foods. "We are at the molecular level figuring out what makes meat meat and reconstituting that from the plant kingdom."

This article is part of our Future of Food series, an initiative sponsored by Land O'Lakes, Inc.

A PALE ALE THAT'S GOOD FOR THE GROUND

When agricultural researchers began worrying in the 1980s about the erosion caused by tillage, they quickly settled on a possible solution: perennial grain. They found one answer to their quest in Kernza, the grain of intermediate wheatgrass, a plant sometimes grown for forage. With a 10-foot root system and the ability to produce for up to six years, Kernza is slowly being ramped up to commercial scale. Its most successful launch to date? A Kernza-based pale ale from Patagonia Provisions.

SILICON VALLEY DISRUPTS OUR WAY OF EATING

Formulated by high-tech workers in search of a nutritious, efficient all-in-one meal, Soylent made its debut in 2013, marketed as a modern, environmentally friendly way to replace traditional food. In 2016, though, the company had to recall its food bars and powder when customers reported vomiting and diarrhea. And a year later Canada banned Soylent for failing to meet legal requirements for meal replacements. But the product's popularity has grown, and it's now available in stores like 7-Eleven and Walmart.

is dispensed through a spigot, says Friedrich, "if it's ground meat, it will not be dissimilar."

Meanwhile edible insects are finding a market in the United States—less as the snacks of Thailand and Mexico and more as high-protein animal feed or an ingredient in processed foods. The environmental appeal, particularly of crickets, is clear. Crickets offer more protein and micronutrients per pound than beef. They thrive in dark, densely crowded conditions, allowing for factory-scale production on a tiny footprint. They produce relatively little waste, unlike some large hog and cattle farms, with their manure lagoons. Aspire in Austin, Texas, operates the largest U.S. food-grade cricket farm and has built a growing business, mostly on ground cricket powder used in baked goods, energy bars, and smoothies. Its entire output for the next two years is already sold.

Food companies also are finding new kinds of fats. Enterprising scientists first harvested algae from the sap of a German chestnut tree, engineered it to produce greater quantities of more nutritious oil, and fed it with Brazilian sugarcane in six-story fermentation vats. Then they pressed it, creating algae oil—a light, neutrally flavored cooking oil with monounsaturated fats and a high smoke point now sold under the label Thrive. The idea, say its backers, is to make an efficient and humane alternative to oils such as palm, the production of which has caused environmental and social devastation. The producers of algae oil say they accomplish this by using cane from fields that have been sustainably certified for labor and environmental practices, powering their factory with spent cane, and achieving higher yields of oil per acre.

Still other solutions take inspiration from nature. Researchers in the United States have tried since the 1980s to develop a perennial grain to supplant annuals such as wheat and corn, which are traditionally tilled every year, robbing the soil of nutrients, increasing erosion, and boosting fertilizer runoff. By the early 2000s, staff at the Land Institute, an ecologically focused agricultural research group in Kansas, were selectively breeding a grain known as intermediate wheatgrass to create a variety with better yield, seed size, and disease resistance.

Today the result, called Kernza, is growing on 500 acres in the United States. A variety of food producers are readying it for market—including Bien Cuit, a high-end bakery in Brooklyn, New York, that has made bread with it, and Hopworks Urban Brewery in Portland, Oregon, which sells a Kernza pale ale through Patagonia Provisions. The hope is that a more resilient grain can help forge a more resilient agriculture.

Whatever our meals may be in 50 years, climate change will require us to make better use of what we already have, says global food expert Raj Patel. "The 21st century is recognizing that the things that were weeds and pests can turn out to be food." □

Tracie McMillan is the author of *The American Way of Eating*.
Grant Cornett specializes in still life photography.

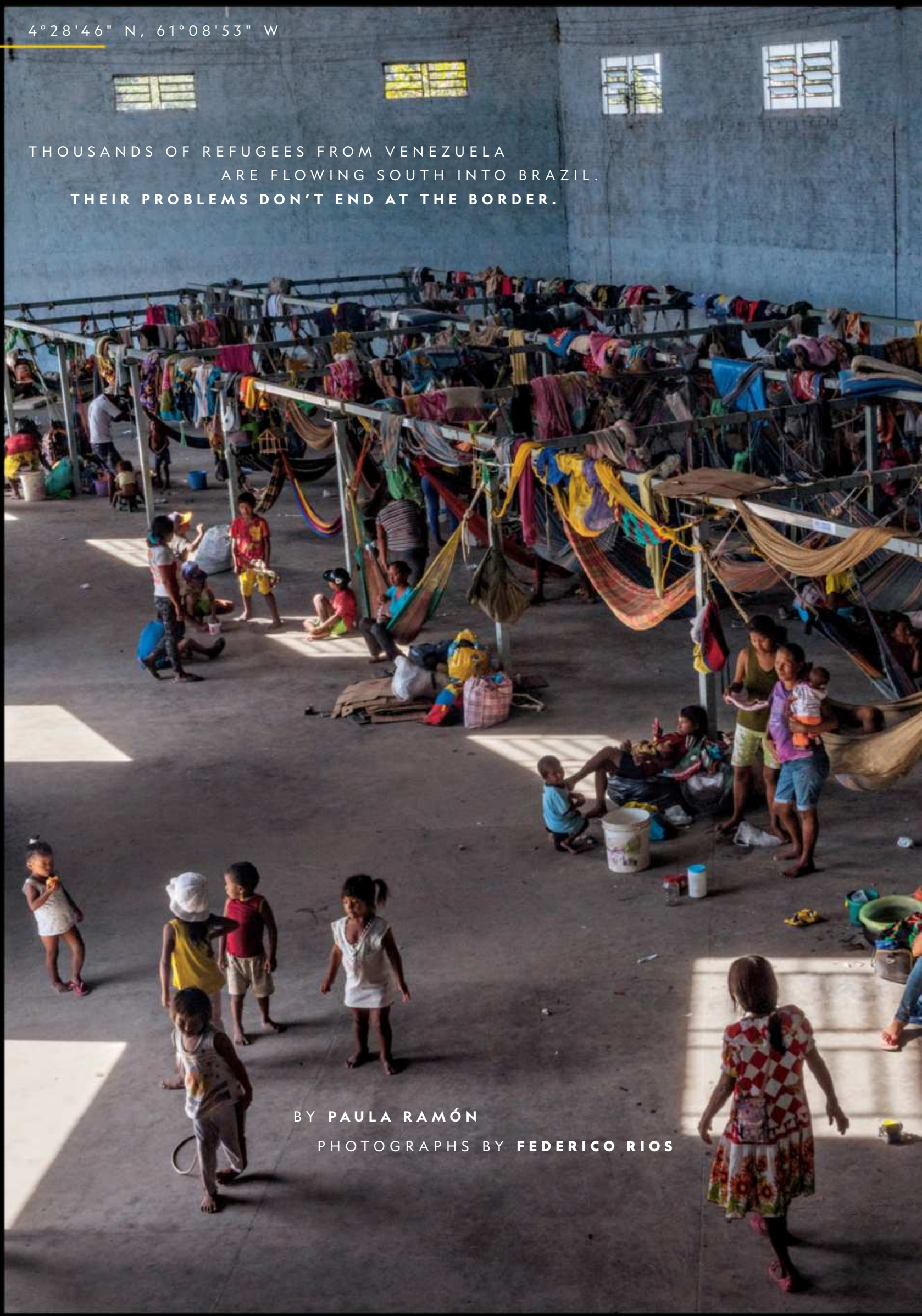
ALGAE OIL: ALTERNATIVE TO PALM OIL

Algae oil, shown dripping from arugula, can be made more sustainably than other oils, its backers say. Palm oil production, for example, has led to deforestation and labor abuses. From one acre of sustainable sugar cane, algae can produce up to 11 tons of neutrally flavored oil with monounsaturated fats. Mark Brooks of Corbion, a Dutch firm that sells algae oil and butter, says many companies want to avoid "chemical-sounding" ingredients, like partially hydrogenated oil. "If you don't want that on your label, you put algae butter instead."

FOOD AND PROP STYLING (ALL): MAGGIE RUGGIERO; REBECCA BARTOSHESKY

4°28'46" N, 61°08'53" W

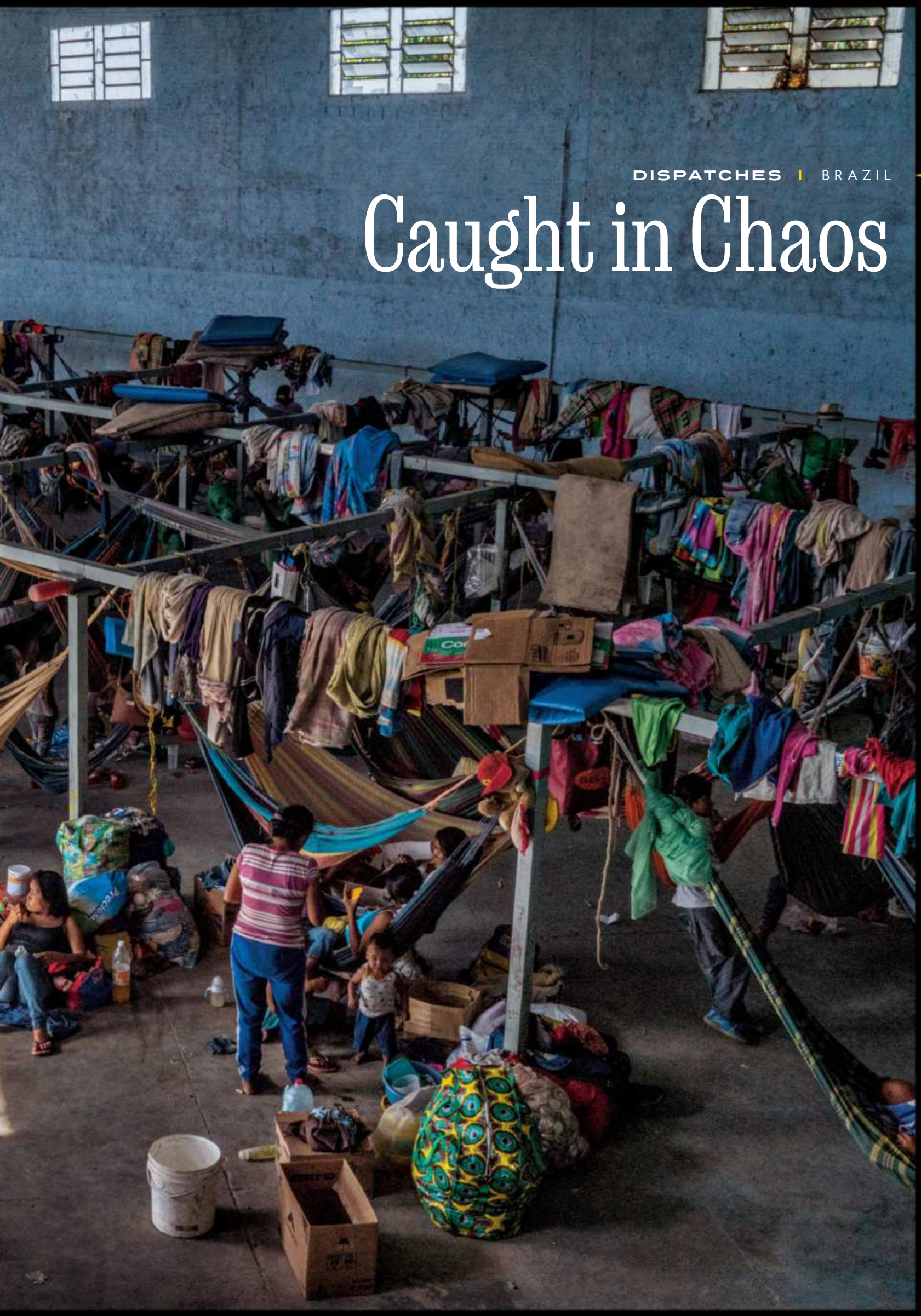
THOUSANDS OF REFUGEES FROM VENEZUELA ARE FLOWING SOUTH INTO BRAZIL. **THEIR PROBLEMS DON'T END AT THE BORDER.**



BY **PAULA RAMÓN**

PHOTOGRAPHS BY **FEDERICO RIOS**

Caught in Chaos



Moraleda family members ride in the back of a pickup after leaving their Orinoco Delta home in Venezuela, where the country's collapse has brought about violence and deprivation. They're hoping to make a better life for themselves in Brazil.

PREVIOUS PHOTO

About 500 members of the Warao tribe live at a concrete shelter outfitted with hammocks and tents in Pacaraima, Brazil. Crowding and unsanitary conditions have contributed to widespread disease.

FISH AND TARO were the only food Milagros Ribero, 35, and her family could find in their little community in the Orinoco River Delta, home of the Warao, the second largest indigenous group in Venezuela. In June they made the 500-mile journey to Brazil.

"We came searching for food," Ribero says near her tent in the Janokoida shelter, recently set up for the Warao in the Brazilian border town of Pacaraima.

Each day hundreds of struggling Venezuelans arrive at the border, carrying stuff on their backs and documents in their hands. Those seeking refuge have sold TVs, cell phones, clothes—everything they own—to pay for the trip. They hope to find food, medicine, safety, and jobs in Brazil, basics they no longer can get in their home country because of its free-falling economy, staggering inflation, high rates of violence, and chronic food and medicine shortages. It's the fallout from a breathtaking collapse in Venezuela, which rode an oil boom from 2004 to 2014 to become one of Latin America's richest nations, then saw its fortunes tumble amid plummeting oil prices, soaring deficits, and persistent corruption.

Since 2017 more than 58,000 Venezuelans have settled in Brazil, the largest migratory movement between the two countries in history. The border region mainly had been known as a place for adventure travelers in search of Mount Roraima, the 9,219-foot plateau that inspired Sir Arthur Conan Doyle's 1912 novel *The Lost World,* which imagines encounters between explorers and dinosaurs. But no adventure awaits those who make it to Brazil. Many run out of money and have their journeys stalled in Pacaraima, which not long ago was a quiet town of 12,375 but now is where hundreds, and likely more, live on the streets, sleeping in tents and parking lots. They gather on sidewalks and cook what they can find, mostly rice, pasta, and beans. Tensions between locals and Venezuelans entering Brazil exploded in August: Fires were set to migrant encampments after an alleged attack on a shop owner.

Pacaraima has 434 homeless Venezuelans officially, but that number

seems understated. Padre Jesús Esteban, a Spanish priest, organizes a daily breakfast of coffee, bread, and fruit for more than 1,500 people. "There are never leftovers," he says.

AFTER LOSING three jobs in a year, Jesús Gómez, 28, left Venezuela with his girlfriend, Eunice Henríquez, 27. They sleep in a tent they used to take to the beach. "It was for travel. Now it's our home," says Gómez, a former security guard. Henríquez, a nurse who gave up her job because her salary was low, now sells coffee in Pacaraima. Her daily pay is enough for one meal. Even in such a precarious situation, the couple—who lived in a small bedroom in Gómez's parents' house—don't regret crossing the border into Brazil.

Many migrants walk another 135 miles to Boa Vista, Roraima's state capital. The city of 332,000 is more vibrant, the economy more stable. Venezuelans are everywhere, asking for jobs. Swarms of people stand at traffic lights, cleaning windshields for coins or selling local products, such as Brazilian flags during this year's World Cup. Rates for laborers have dropped to less than $10 a day. Desperate migrants often move from city to city, hoping things will get better.

Two centers, one each in Pacaraima and Boa Vista, have been designated for the Warao. They cook over wood fires, weave and sell crafts, and try to maintain some of their routines. There is health care as well as food, but the conditions are precarious. In one of the shelters, the smell of sewage is overpowering, and with the rainy season one courtyard is flooded.

The Brazilian government, working with the United Nations and nongovernmental organizations, has opened nine refugee centers in Boa Vista. More migrants are waiting to join the 4,200 refugees there. The plan is to send them to other Brazilian states and welcome new migrants, but the process is slow. Although some manage to rent small spaces on the outskirts of the city, life is so hard that a few consider going home.

"There's nothing else to do here," says Adriana Bolívar, 21, who shares a tiny room with her family. "We've been so humiliated. I know this is not my country, but if they only put themselves in our shoes, they would understand that we're only trying to survive." □

Indigenous Exodus

The Warao people, a native group from the Orinoco River Delta in Venezuela, are fleeing hunger and disease as state support collapses. Unable to sustain themselves in their rural homeland, they're hitchhiking, taking buses, and walking to refugee centers to trade their village ways for city life in Brazil.

*ESTIMATED NUMBER IN SHELTERS
RILEY D. CHAMPINE, NGM STAFF. SOURCE: UNHCR

A Warao woman cooks dinner over a campfire near Ciudad Guayana, Venezuela, on the way to the Brazilian border. Many Warao walk or hitchhike to shelters in Brazil, a journey that can take days.

Top: Grandmother Delia Estrella and Ingrid Moraleda, 13, ride from Las Claritas to Santa Elena with their family in search of food and health care. Ingrid tends to her grandmother, who had never left the Orinoco Delta until this trip. Above: Hammocks provide traditional sleeping arrangements over the concrete floor at Pacaraima's Janokoida shelter. These two brothers have lived there for several months.

Top: Bare tents supplied by the Pacaraima shelter are a reminder of how far the Warao are from their delta home. Above: A local money trader on the Brazilian side of the border shows five million Venezuelan bolivares, equivalent on the black market to two U.S. dollars at the end of March 2018. The value of Venezuelan currency changes daily because of inflation.

TURKEY'S PLAN TO CONTROL ITS MOST PRECIOUS RESOURCE INCLUDES A CONTROVERSIAL DAM THAT WILL LEAVE MANY TOWNS UNDERWATER.

Flooding History

BY **SUZY HANSEN**

PHOTOGRAPHS BY **MATHIAS DEPARDON**

The ancient town of Hasankeyf sits on the bank of the Tigris River. The Ilısu Dam will cause the river to rise some 200 feet, submerging this modern café, the ruins of the 900-year-old bridge behind it, and Neolithic caves (in the background).

MATHIAS DEPARDON, INSTITUTE

Hasankeyf is a 12,000-year-old village carved into a plateau flanking the Tigris River.

It looks like something out of a surreal fairy tale. Overlooking the town are caves crafted by Neolithic pioneers and the ruins of a citadel as old as the Byzantines. The settlement bears traces of the Romans. It's the site of significant medieval Islamic architecture, including a bridge across the Tigris that established it as an important outpost along the Silk Road. Marco Polo may have crossed there on his way to China.

Hasankeyf is also an active town in southeastern Turkey, with markets and gardens and mosques and cafés—a place with a palpable feeling of historical continuity and survival.

Yet in 2006 the Turkish government officially began work on a giant dam across the Tigris River that will lead to the drowning of an estimated 80 percent of Hasankeyf and the displacement of its 3,000 residents, as well as many other people. The dam—the Ilısu—is now almost complete, and the flooding could start anytime in the next year.

Why would a country demolish one of its most mythic places? To improve the lives of the local people through modernization, the government says. But the massive project benefits the Turkish state too. Turkey has no native oil or natural gas sources. What it does have is water.

IN THE EARLY DECADES of the 20th century, the Turkish Republic engaged in a series of state-driven modernization projects intended to develop its economy. The southeastern region—its inhabitants relatively poor, undereducated, and minority Kurds, Arabs, and Assyrians—was largely left out. In the 1970s the government

Atatürk Dam is Turkey's largest. Named after Kemal Atatürk, the country's founder, the dam was built on the Euphrates River in the 1980s as part of Turkey's sweeping Southeastern Anatolia Project to generate electricity, bolster the region's economy, and irrigate rural areas.

proposed a remedy: a colossal dam project that would bring reliable electricity to the southeast and irrigate the farmlands. The Turkish government would build 22 dams and 19 hydroelectric power plants across the Tigris and Euphrates river network, as well as roads, bridges, and other forms of infrastructure. The plan was dubbed the Southeastern Anatolia Project (GAP, as the acronym goes in Turkish).

The GAP soon became controversial. Syria and Iraq, downstream from Turkey, protested that Turkey could deprive them of much needed water. In 1984 the Kurdistan Workers Party (PKK), a militant separatist group—terrorists, according to Turkey and the United States—revolted against perceived injustices committed by the Turkish state, turning the southeast into a war zone. Meanwhile, European banks withdrew funding and the World Bank denied loans because of ongoing multinational disagreements, inadequate environmental assessments, and concerns about the scope of resettlement and cultural heritage protection. Even within the Turkish government, enthusiasm for the GAP as a national pride project began to fade, according to Hilal Elver, who advised the Ministry of Environment in the 1990s and is now the UN Human Rights Council's special rapporteur on the right to food.

Indeed, by the 2000s it had become clear that the dam projects weren't succeeding in

Leyla Sonkuş picks grape leaves on the Plain of Harran in southern Turkey, not far from the Syrian border. The irrigation of Harran is considered one of the project's successes, but people in Syria and Iraq complain that Turkey's dams threaten water flows from the Euphrates and Tigris Rivers, endangering farmlands and the supply of clean drinking water.

Editor's note

While on assignment for this story, French photographer Mathias Depardon was arrested by Turkish police and imprisoned for 32 days. He was not formally charged, and no reason was given for his eventual release. Although Depardon had lived in Turkey for five years, he was banned from the country for at least 12 months. Before the arrest, he had shot more than a hundred rolls of film—all were recovered and sent to National Geographic.

their ostensible purpose. "They mismanaged the water, and it didn't bring development and it didn't bring peace," said Elver, noting that the PKK and the government are still fighting. Today electricity generated by 13 of 19 completed dams is mostly used elsewhere. Salination, a direct result of introducing water to poorly drained salty lands, has ruined precious farms. Income from the dams hasn't trickled down to local municipalities or people. Thousands have been displaced. Most received monetary compensation and housing but not enough to replace long-held livelihoods.

The Ilısu Dam may be one of the GAP's most destructive projects yet. It's set to flood not only Hasankeyf but also 250 miles of river ecosystem, 300 archaeological sites, and dozens of towns and villages. Some of the artifacts will be moved to safer ground, but the dam will displace about 15,000 people and affect tens of thousands more. Ercan Ayboğa, an environmental engineer and spokesperson for the Initiative to Keep Hasankeyf Alive, says the number might be close to 100,000. "It's a huge project imposed on the people of the region by the Turkish government," Ayboğa said. It "has no benefits for the local population except profits for some companies and big landowners."

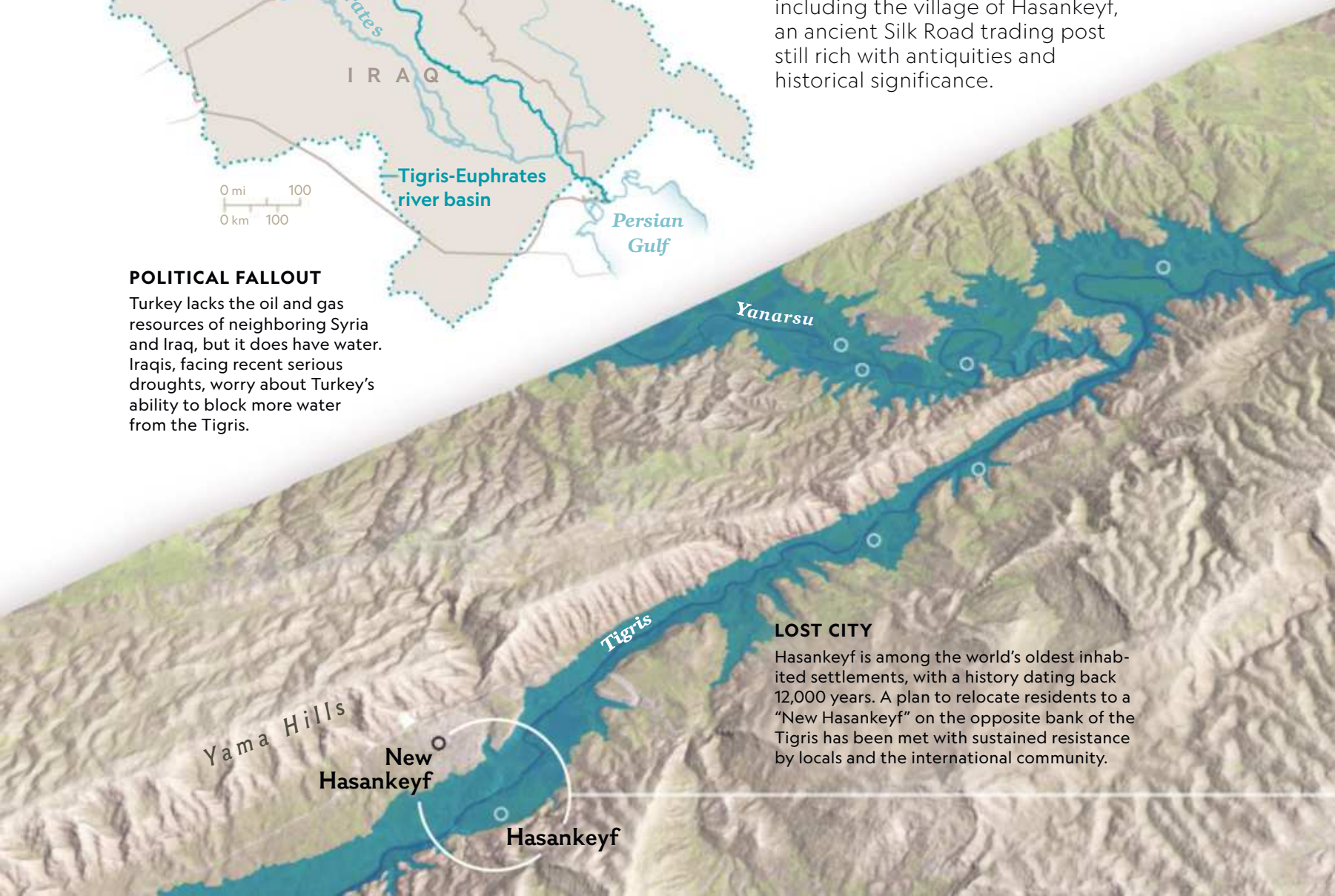
So why does the Turkish government press on? After all, other countries, including the U.S., are reconsidering the benefits and risks of dam projects and even removing some dams to restore natural water flow and river habitats. And there are less destructive ways to generate electricity, such as solar power.

Where the Water Will Rise

The Ilısu Dam is one of the largest of the now 29 planned dams that form the backbone of a decades-long infrastructure project in Turkey. When the dam is finished, 2.7 trillion gallons of water are expected to flood up to 120 square miles of land along the Tigris River, including the village of Hasankeyf, an ancient Silk Road trading post still rich with antiquities and historical significance.

POLITICAL FALLOUT

Turkey lacks the oil and gas resources of neighboring Syria and Iraq, but it does have water. Iraqis, facing recent serious droughts, worry about Turkey's ability to block more water from the Tigris.



LOST CITY

Hasankeyf is among the world's oldest inhabited settlements, with a history dating back 12,000 years. A plan to relocate residents to a "New Hasankeyf" on the opposite bank of the Tigris has been met with sustained resistance by locals and the international community.

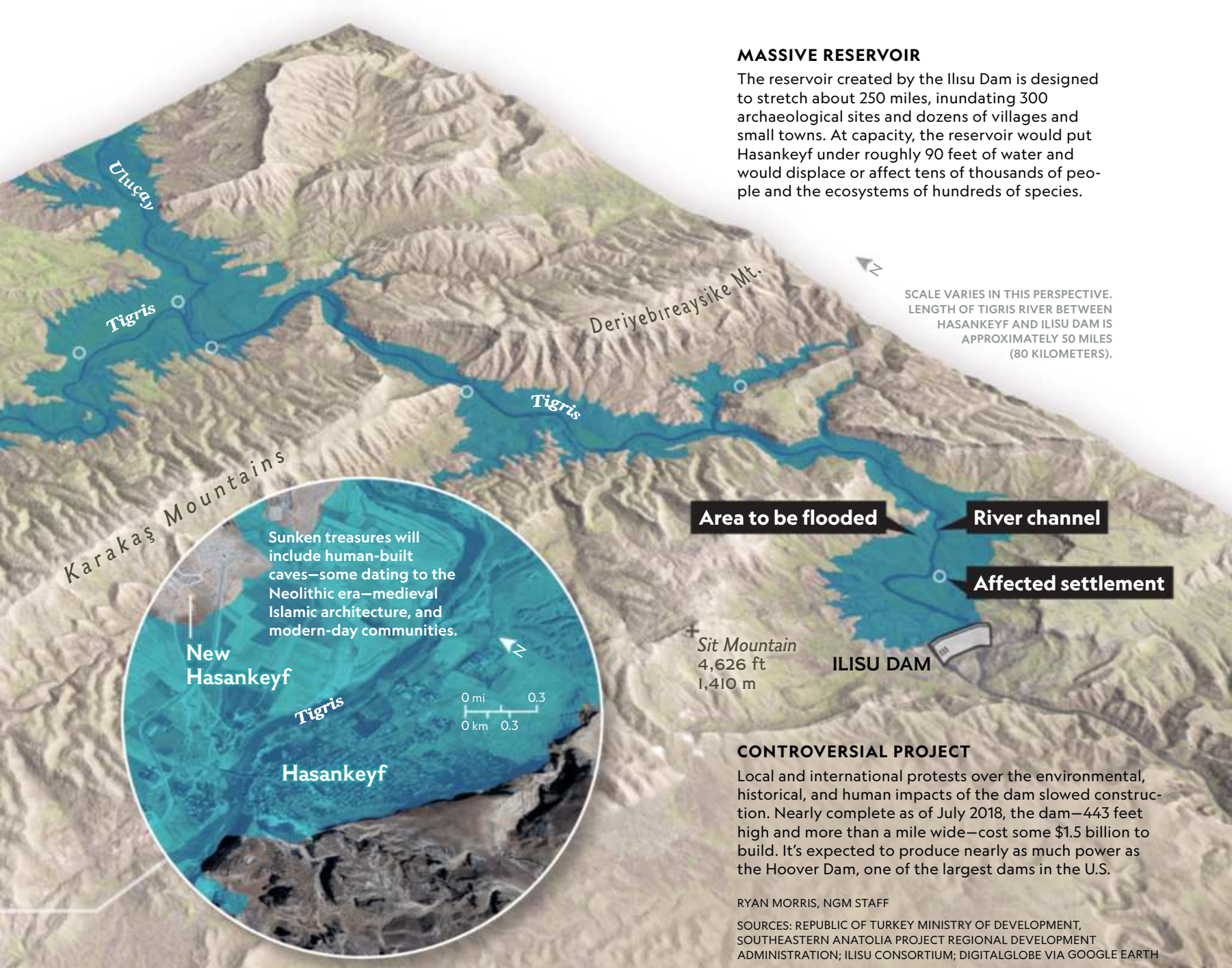
Many believe that the government's goal is simply to control this natural resource, for Turkey's domestic needs and for its security. Case in point: When the PKK's leader, Abdullah Öcalan, found shelter in Syria, one of Turkey's bargaining chips to get him back was that it could shut off the country's water supply. Water "can be used as a weapon against Iraq and Syria," said John Crofoot, an American part-time resident and founder of Hasankeyf Matters. "It's leverage."

This past spring Iraq's drought worsened, and the Tigris trickled to dangerous lows. The Iraqi government lobbied against the Turkish plan to start filling the reservoir created by the Ilısu Dam in June. The Turks acquiesced. Fatih Yıldız, the Turkish ambassador to Iraq, told critics, "We have shown once again that we can put our neighbor's needs ahead of our own." But for decades the government's attitude has basically remained the same: Iraq has oil, but Turkey has water—and it can do with that what it pleases.

PEOPLE IN HASANKEYF protested in March, after government officials served the merchants who worked in the historic bazaar with eviction papers and told them to start moving to new commercial properties in New Hasankeyf, a series of bland, mostly uninhabited buildings on a nearby plain. The merchants argued that their businesses couldn't be supported by a ghost town. The eviction, they said, violated their human right to work. They prevailed, if only temporarily.

In the years since the dam construction began, the people have been living in a vague, agonizing limbo, not knowing when they will have to leave their homes. The last anyone heard, the government was going to start filling the reservoir in July. That didn't happen. So the people wait, and live. It's as if the longer Hasankeyf is not flooded, the easier it is to believe that it never will be. ▯

Suzy Hansen is a writer living in Istanbul. Her first book, *Notes on a Foreign Country,* was a finalist for the Pulitzer Prize.



MASSIVE RESERVOIR

The reservoir created by the Ilısu Dam is designed to stretch about 250 miles, inundating 300 archaeological sites and dozens of villages and small towns. At capacity, the reservoir would put Hasankeyf under roughly 90 feet of water and would displace or affect tens of thousands of people and the ecosystems of hundreds of species.

SCALE VARIES IN THIS PERSPECTIVE. LENGTH OF TIGRIS RIVER BETWEEN HASANKEYF AND ILISU DAM IS APPROXIMATELY 50 MILES (80 KILOMETERS).

CONTROVERSIAL PROJECT

Local and international protests over the environmental, historical, and human impacts of the dam slowed construction. Nearly complete as of July 2018, the dam—443 feet high and more than a mile wide—cost some $1.5 billion to build. It's expected to produce nearly as much power as the Hoover Dam, one of the largest dams in the U.S.

RYAN MORRIS, NGM STAFF

SOURCES: REPUBLIC OF TURKEY MINISTRY OF DEVELOPMENT, SOUTHEASTERN ANATOLIA PROJECT REGIONAL DEVELOPMENT ADMINISTRATION; ILISU CONSORTIUM; DIGITALGLOBE VIA GOOGLE EARTH

In the years since construction of the Ilısu Dam began, the people of Hasankeyf have been living in a vague, agonizing limbo, not knowing when they will have to leave their homes.

Before the deluge (clockwise from top left): Residents keep beds on their roofs to escape the summer heat; the minaret in the background will be moved to an archaeological park. A Kurdish boy visits one of thousands of human-made caves, some of which are Neolithic. Kurdish women, already displaced, rest on a hill overlooking the Ilısu Dam construction site 50 miles downstream from Hasankeyf. Kurdish girls relax in a home that will be flooded.

MATHIAS DEPARDON, INSTITUTE (ALL)

Savaşan village in the district of Halfeti offers a glimpse of Hasankeyf's future. In 2000 the village was submerged, along with eight others, by the Birecik Dam. Despite the project's promise of helping agriculture, the farmland belonging to the people of Halfeti now lies largely beneath the water. Tour boats pass by a drowned mosque, but tourism hasn't yet made up for the community's economic loss.

MATHIAS DEPARDON, INSTITUTE

A CRACK IN THE WORLD

AS THE ANTARCTIC HEATS UP, THE RULES OF LIFE THERE ARE BEING RIPPED APART.

ALARMED SCIENTISTS AREN'T SURE WHAT ALL THE CHANGE MEANS FOR THE FUTURE.

BY
CRAIG WELCH

PHOTOGRAPHS BY
PAUL NICKLEN, CRISTINA MITTERMEIER & KEITH LADZINSKI

The warming is changing what animals eat, where they rest, and how they raise their young.

Crabeater seals slither onto floating ice to nap, give birth, or hide from killer whales or leopard seals. (Note the prominent scars.) With less sea ice available off the Antarctic Peninsula, icebergs like this one, calved from glaciers on land, provide critical resting places for animals. Despite their name, crabeaters feed mostly on shrimplike krill—another Antarctic staple whose future is in doubt.

CRISTINA MITTERMEIER

PREVIOUS PHOTO

Sea-worn stones form a path to beached and broken sea ice. Ice is central to life along the 800-mile Antarctic Peninsula, which juts up toward South America, but warming air and water are melting it on land and sea.

KEITH LADZINSKI

A young blue-eyed shag attempts what may be its first dive near shore. Many flying seabirds nest or feed along the Antarctic Peninsula.

CRISTINA MITTERMEIER

Dion Poncet came of age in a place almost no one calls home.

Much has changed in the South Atlantic since Dion Poncet criss-crossed it as a boy on his parents' sailboat. They ranged from South Georgia, where nine-year-old Dion (at left) and brother Leiv stand watch in 1988, south to Antarctica. "The Antarctic Peninsula I knew as a child has largely gone," Poncet says.

FRANS LANTING, NATIONAL GEOGRAPHIC CREATIVE

ONLINE

Visit *ngm.com/Nov2018* to see videos made by the National Geographic team as they traveled along the Antarctic Peninsula in 2017 on Dion Poncet's boat.

HE WAS BORN ON A SAILBOAT in Leith Harbour, an abandoned whaling station on South Georgia island. His father, a French adventurer, had met his mother, an Australian zoologist, on a jetty in Tasmania while sailing his boat around the world. The couple started a family in the South Atlantic. For years they traversed the west coast of the Antarctic Peninsula, surveying wildlife in uncharted bays—seals, flowering plants, seabirds—with three boys in tow. Dion was the first.

The Antarctic Peninsula is an 800-mile string of mountains and volcanoes that juts north from the White Continent like the tail on a horseshoe crab. It was Poncet's playground. Young Dion and his brothers read, drew, and played with Legos—but also chased penguins, lifted chocolate from derelict research stations, and sledded down hills that might never have seen a human footprint. Other kids face schoolyard bullies; Dion was tormented by dive-bombing skuas, which whacked his head hard enough to make him cry. Other kids star in wobbly home movies; the Poncet boys were featured in a 1990 National Geographic film about growing up in the Antarctic. Sometimes, during breaks from homeschooling, Dion's mom had him count penguins. "It got pretty boring pretty quickly," he says.

On a frigid evening nearly 30 years later, Poncet and I stood in the wheelhouse of his 87-foot boat, the *Hans Hansson,* scanning the ice for Adélie penguins. At 39, Poncet is blond, block-jawed, and quiet, with enormous hands. He has spent much of his adult life ferrying scientists and other visitors in charter boats through the waters around South Georgia and Antarctica from his base in the Falklands. Along with a team of photographers led by Paul Nicklen, I had joined him for a voyage along the west coast of the Antarctic Peninsula. We wanted to see how things were changing in a region he'd known his whole life.

Here at the bottom of the world, a place all but free of human settlement, humanity is scrambling one of the ocean's richest wildernesses. Fossil-fuel burning thousands of miles away is heating up the western peninsula faster than almost anywhere else. (Only the Arctic compares.) The warming is yanking apart the gears of a complex ecological machine, changing what animals eat, where they rest, how they raise their young, even how they interact. At the same time, the shrimplike krill upon which almost all animals here depend for food are being swept up by trawlers from distant nations. They're being processed into dietary supplements and pharmaceuticals, and fed to salmon in Norwegian fjords and to tropical fish in aquariums.

So much here is changing so fast that scientists can't predict where it's all headed. "Something dramatic is under way," says Heather Lynch, a penguin biologist at Stony Brook University. "It should bother us that we don't really know what's going on."

What we can see is troubling enough. On the western peninsula, Adélie penguin populations have collapsed, some by 90 percent or more. Records of great hordes of the birds in one bay date back to 1904; today in that spot "there are only about six nests left," Poncet says. That day in the wheelhouse, when Poncet and I spotted our first massive colony, we had left the west for the peninsula's northeast tip.

On tiny Paulet Island, thousands of penguins were perched in rows up a rocky slope, evenly spaced, like an audience at an opera house. We could see some wandering the remains of an old stone hut built in 1903 by shipwrecked Swedish explorers, who survived a long Antarctic winter by eating penguins. On an iceberg off our starboard beam, a noisy cluster of penguins slipped and knocked about like wobbly bowling pins. When I saw one glissade down polished ice, its flippers pulled back in a skier's tuck, then tumble into a trio of fellow birds, I laughed out loud. Poncet just nodded.

Antarctica is not all death and chaos: Millions of Adélies still thrive around the continent, performing their unintentional comedy. But the western peninsula's transformation is profound, and few have seen more of it unfold than Poncet. The world he once knew is unraveling. He speaks of the loss like a farm kid who has watched suburbia gobble the family homestead.

"All the things you used to experience, the places I went when I was a child—I took it for granted then," Poncet says. "Now you realize it's not ever going to be possible again."

MUCH OF ANTARCTICA is a vast plateau, a high desolate desert of blowing snow where temperatures can plunge to minus 140°F. Poncet's Antarctica isn't like that at all.

The nonprofit National Geographic Society, working to conserve Earth's resources, helped fund this article.

Winter air on Antarctica's western peninsula has warmed more than 10 degrees Fahrenheit since the 1950s.

A fur seal rests near a snow-covered pile of whale bones. Unlike many whale species, fur seals made a remarkable recovery after hunting them was banned in Antarctica. Now the population in the South Shetland Islands is falling again—an indirect result of melting sea ice, which is driving leopard seals ashore to feast on fur seal pups.
PAUL NICKLEN

PREVIOUS PHOTO

Adélie penguins slip and slide on ice; behind them, on Paulet Island, thousands more line the rocky, guano-streaked slopes. Adélie colonies along the peninsula's western shores have collapsed as waters have warmed. But here on the peninsula's northeast tip, winds and ocean currents keep waters a little cooler, and Adélies are thriving.
PAUL NICKLEN

The Antarctic Peninsula is longer than Italy and curls north toward the temperate zone. Its climate—for Antarctica—has always been mild. Summer temperatures often rise above freezing. Isolated patches of vegetation dot exposed granite and basalt. Adélie penguins live all along the coast of Antarctica, but the peninsula also supports species the harsh mainland can't: fur seals, elephant seals, gentoo and chinstrap penguins. Petrels and sheathbills flit about the skies. All this life relies on the sea.

On the rugged peninsula, Antarctica's stillness is punctuated by squawking and chattering and concentrated motion. It's a place of bizarre angles: Blue-white glaciers flow to the ocean and calve into icebergs that assume every form imaginable. Bergs the size of small towns reach into the clouds. Even dozens of miles away, you hear them crack and explode like cannons.

It looks like wilderness, and it is, but it is not untouched. People began altering life in this region decades before anyone had even seen Antarctica. Not long after Capt. James Cook first cut through Antarctic waters in the 1770s, hunters started slaughtering fur seals by the millions, mostly for hats and coats. They also killed elephant seals for oil, to be used in paint and soap. The first to set foot on the continent were probably Connecticut seal hunters who came ashore briefly on the western peninsula in 1821.

In time whalers began harpooning sei whales, blues, fins, and humpbacks. They stripped baleen, or whalebone, from their mouths to make whips, umbrella ribs, corsets, and carriage springs and used the whale oil for heat, lamps, and margarine. In the early 20th century South Georgia became a whaling mecca. Leith Harbour was the last of its stations to close, in 1966.

Climate change has since left an unmistakable mark. Winter air on the western peninsula has warmed more than 10 degrees Fahrenheit since the 1950s. Winds drive changes in ocean circulation that bring warmer deep water toward the surface, helping to reduce sea ice—the broken crust that forms when the ocean's briny surface freezes. Sea ice now appears later and disappears faster: The ice-free season on the western peninsula lasts a full 90 days longer than in 1979. For a Northern Hemisphere equivalent, imagine summer suddenly stretching to Christmas.

The winter before Poncet was born, his parents spent weeks camping and exploring frozen Marguerite Bay, hauling gear by sledge across its

Translucent krill, about two inches long, are the centerpiece of the Antarctic food web. Fish, squid, penguins, seals, and whales all consume krill—and so do we. Ships from various countries come to Antarctica to net swarming krill by the billions, for use in dietary supplements or to feed farmed salmon and aquarium fish.
KEITH LADZINSKI

solid surface. "Nowadays," Poncet sa
finished. Sea ice barely even forms."

The loss of ice exposes warm water
air, increasing evaporation, which ret
world's driest continent as snow—ev
a 2016 trip to Marguerite Bay, halfway
west coast, Poncet faced a deluge t
almost a week. "Thirty years ago I c
anyone had ever seen a drop of wate
the sky down there," he says.

The balmier water pulled from the
affects ice on land, by attacking glac
they meet the sea as floating shelve
596 of the western peninsula's 674 g
in retreat, according to a British su
where in Antarctica, far larger ice s
thawing and crumbling, threatening
in global sea levels. On the east coast
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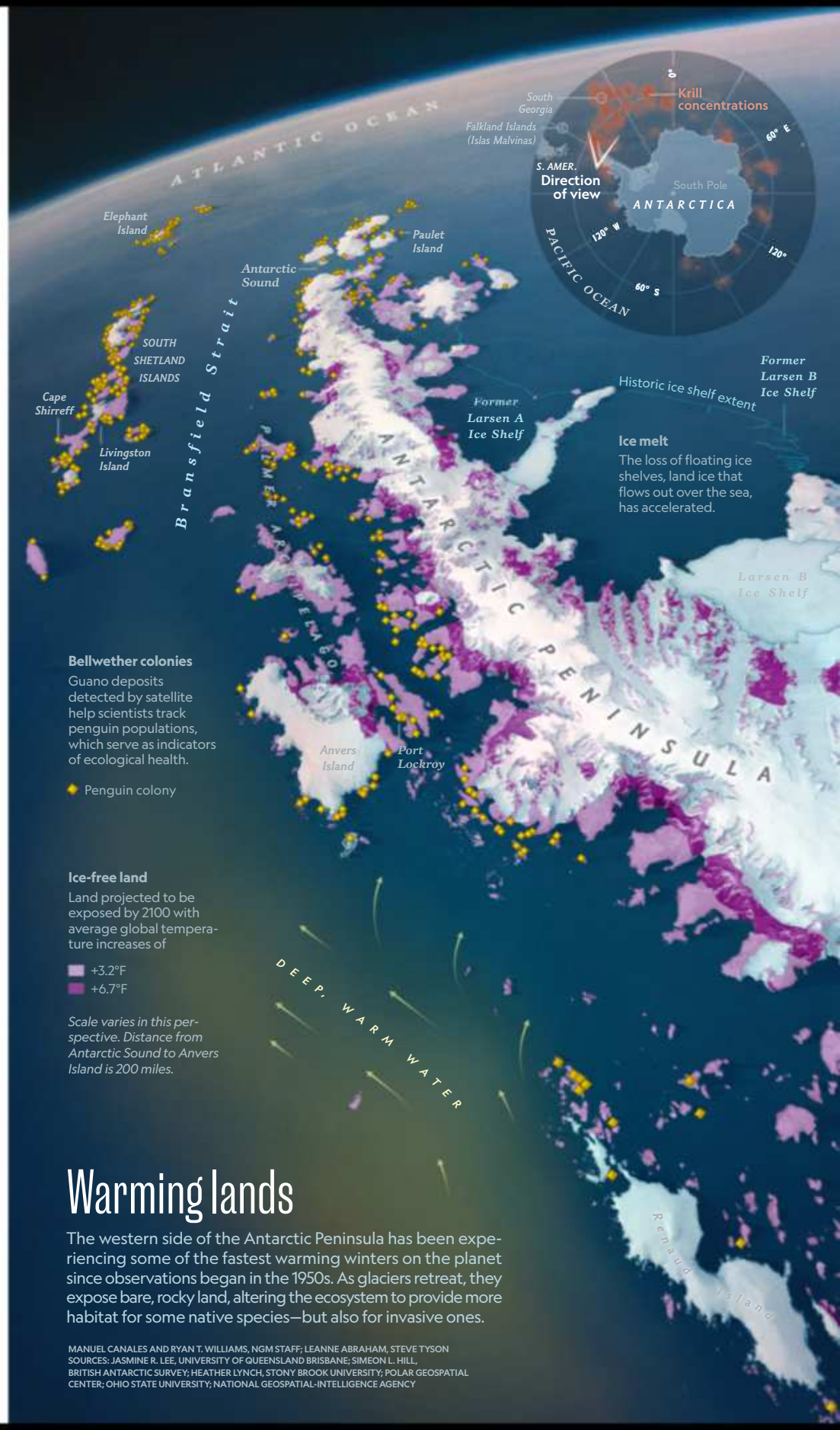
too—a Delaware-size piece broke off the Larsen C Ice Shelf just last year. But the east coast can still be five degrees Fahrenheit cooler than the west. Prevailing winds often push sea ice from the west around the tip of the peninsula to the east, where a gyre traps it against land.

The western peninsula is Antarctica’s hot spot. Often depicted on maps in white, it’s now so warm that tufts of the continent’s only native flowering plants, hair grass and yellow-flowered pearlwort, are spreading. So are invasive grasses and lichens. Green moss is growing three times as fast as it did in the past. Island peaks once cloaked in snow are now wet and melting, exposing mud or yawning crevasses.

“The landscape is shriveling,” Poncet says.

Hiking recently on the south shore of Elephant Island, off the tip of the peninsula, Poncet was flabbergasted by how temperate things seemed.



Warming lands

The western side of the Antarctic Peninsula has been experiencing some of the fastest warming winters on the planet since observations began in the 1950s. As glaciers retreat, they expose bare, rocky land, altering the ecosystem to provide more habitat for some native species—but also for invasive ones.

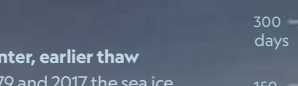
MANUEL CANALES AND RYAN T. WILLIAMS, NGM STAFF; LEANNE ABRAHAM, STEVE TYSON
SOURCES: JASMINE R. LEE, UNIVERSITY OF QUEENSLAND BRISBANE; SIMEON L. HILL, BRITISH ANTARCTIC SURVEY; HEATHER LYNCH, STONY BROOK UNIVERSITY; POLAR GEOSPATIAL CENTER; OHIO STATE UNIVERSITY; NATIONAL GEOSPATIAL-INTELLIGENCE AGENCY

Sea change

Global warming is heating deep waters circulating from northern oceans. As winds blow away colder surface water, the warmer waters rise from below, making sea ice and glacial ice thinner. A warming climate also increases storminess, which pushes sea ice south.

Delayed winter, earlier thaw

Between 1979 and 2017 the sea ice season contracted, with winter sea ice forming two months later and thawing one month earlier. Natural climate fluctuations don't explain this change.



Prey under pressure

The ice-free fishing season now extends deeper into fall. Strict quotas limit krill catch size, but the shorter sea ice season and the longer fishing season could put humans and wildlife in more competition for the same prey.

With less sea ice, heat from the water is released into the atmosphere, further warming the region.

Algae is frozen and released from ice seasonally.

Sea ice and krill

Larval and juven
on seasonal alga
the underside o

DISAPPEARING SEA ICE

Winners and losers

Animals that hunt in open water and breed on rocky shores along the western Antarctic Peninsula may fare well as sea ice retreats. Others that depend on sea ice for food, protection, and a place to rest will likely face decline.

SPECIES TREND

- Increase
- Decrease
- Unknown

Antarctic fur seal
Arctocephalus gazella

The South Shetland Island population is in decline, partly due to leopard seals preying on young pups.

Gentoo penguin
Pygoscelis papua

Gentoos have a varied diet and don't rely on the annual return of sea ice. Their numbers are soaring.

KRILL SWARM

Humpback whale
Megaptera novaeangliae

Humpbacks are thriving now in open, ice-free waters, where they feed on dense krill swarms. But they could be affected if krill decline.

KRILL: KEYSTONE SPECIES

Whales, seals, fish, and seabirds such as penguins eat massive quantities of these nutritious, pinkie-size crustaceans. At times the world's total krill population outweighs all humans on Earth.

Antarctic krill
Euphausia superba

ICE-AVOIDING SPECIES ICE-DEPENDEN

WESTERN ANTARCTIC PENINSULA

VANISHING SEA ICE

As the sea ice season off the west coast of the Antarctic Peninsula shrinks, species that rely on the ice will have to adapt or perish. The loss of ice could also reduce krill populations. Many species consume these tiny crustaceans, which for now are still abundant.

ile krill feed
e blooms on
f sea ice.

More rain
Rain is increasing in the region, flooding penguin nests and freezing chicks.

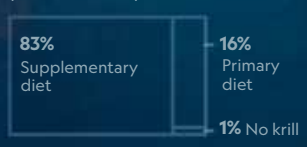
Breeding versatility
Unlike gentoos, Adélies can't quickly lay more eggs if nests are destroyed by rain.

Antarctic minke whale
Balaenoptera bonaerensis
These small, agile whales pursue krill only under ice, where they also find protection from killer whales.

Adélie penguin
Pygoscelis adeliae
Adélies eat only krill and krill-eating fish. They also rely on sea ice as a surface on which to haul out and rest.

KRILL SWARM

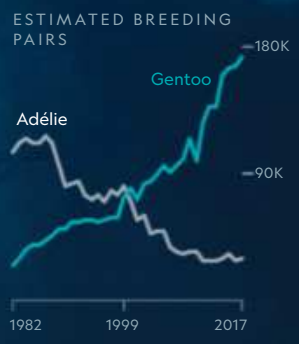
Krill is the primary or supplementary diet of 99 percent of area predators.



Leopard seal
Hydrurga leptonyx
These apex predators feed on fish, penguins, krill, and other seals. They hunt near and below sea ice and may breed atop it.

ADÉLIES VS. GENTOOS

Adélies, which specifically evolved to survive harsh, icy conditions, are in steep decline along the western peninsula. Ecologically flexible gentoos are thriving.



MANUEL CANALES, RYAN T. WILLIAMS, AND TAYLOR MAGGIACOMO, NGM STAFF. MESA SCHUMACHER. ART: GAËLLE SEGUILLION. SOURCES: KIM BERNARD, OREGON STATE UNIVERSITY; HEATHER LYNCH AND CATHERINE M. FOLEY, STONY BROOK UNIVERSITY; SHARON STAMMERJOHN, UNIVERSITY OF COLORADO BOULDER; ADRIAN DAHOOD AND ARI FRIEDLAENDER, UNIVERSITY OF CALIFORNIA, SANTA CRUZ

NT SPECIES

The weather was humid, the landscape ice free, and enough grass had sprouted that it brought to mind a meadow.

"It didn't feel like Antarctica at all," he says.

A **HEAVY RAIN** is falling as we depart the *Hans Hansson* one morning on black rubber rafts, bound for a pebbly shore near the Antarctic Sound, at the northern tip of the peninsula. On a rocky shelf colored like a sunset by streaks of guano, we spy several muddy Adélie penguins. One is a fledgling, whose gray, pillowy down is damp and matted.

Adélies are the peninsula's only truly Antarctic penguin species. (Chinstraps also live in South America; red-beaked gentoos range from there to Africa.) They build nests of pebbles and return to the same site each year at the same time, even if it's raining or snowing or ice is melting. They prefer dry rock or soil but now are often forced to build on light snow—only to have nests collapse when the snow melts or fill like ponds when it rains. Adélie eggs are drowning in flooded nests. Drenched and windblown chicks are freezing to death; they lack the moisture-repelling feathers that protect adults.

Adults, meanwhile, struggle with lost sea ice. Adélies molt on floes far at sea and use ice as way stations to avoid predators between hunts. They can swim for days but tend to dive only in the upper few hundred feet of sea. As waters warm, more adaptable penguins are pushing in. Gentoos—fat, tall generalists—are more flexible about when and where they build nests and are more apt to lay new eggs if nesting fails. They hunt closer to land and eat whatever is available. From 1982 to 2017, the number of breeding pairs of Adélies along the western peninsula and

A damp Adélie fledgling struggles to shake the moisture from its muddy down. Warming has increased precipitation so much along the western Antarctic Peninsula that many penguin chicks—whose moisture-repelling feathers haven't yet come in—get soaked and then freeze to death in polar winds. Eggs, meanwhile, are drowning in flooded nests.

CRISTINA MITTERMEIER

South Shetland Islands dropped by more than 70 percent, from 105,000 to 30,000. Gentoo pairs saw a sixfold increase, from 25,000 to 173,000.

Ice is essential to more than just Adélies. It's as central to this region as grass is to the savanna. When it disappears, relationships can shift unpredictably. One morning near the Antarctic Sound, Nicklen, photographer Keith Ladzinski, and I zip into dry suits and go snorkeling near shore. We watch a skittish Adélie survey the waves from a crumbling raft of ice. The bird seems hesitant to plunge in—with good reason. A leopard seal is circling and occasionally nosing onto the ice.

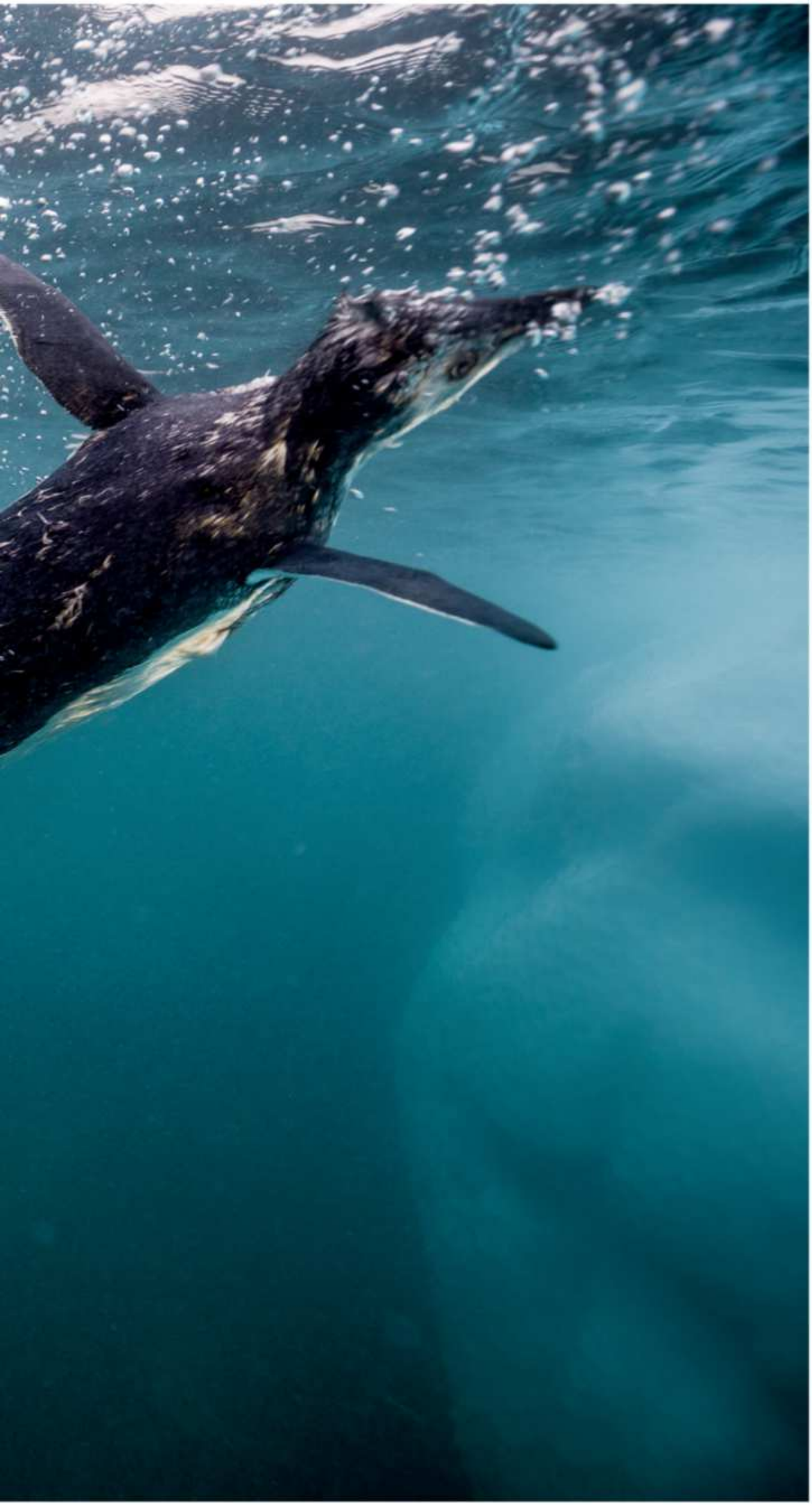
A leopard seal can weigh half as much as a small car. Its toothy jaws open wider than a grizzly bear's. When closed, its mouth curves in a mischievous smile. That's how the predator looks as it corkscrews around us—rakish, impatient, the king of its domain.

Suddenly, two more leopard seals appear. They turn in lazy laps, spiraling one after the other. Soon there are two more, their eyes locked on other penguins. One by one, the birds slip into the water, and the seals give chase. Some penguins turn and scamper back to ice and safety. Others aren't so lucky. In an area not much bigger than two suburban backyards, five seals are soon feasting on penguins, shaking and shredding their bloody prey.

The show is mesmerizing—and "highly unusual," Tracey Rogers, a leopard seal expert at the University of New South Wales, later tells me. Leopard seals, like grizzlies, are solitary creatures that usually stake out vast territories offshore. They need ice floes to rest on between hunts. Loss of ice from climate change is leading them to congregate near land, shifting how, where, and even what they hunt.

Leopard seals used to be rarely seen near fur seal breeding grounds. "Some sealers in the 1800s kept meticulous logs and records," says Doug Krause, a wildlife biologist with the National Oceanic and Atmospheric Administration. "None of them reported seeing leopard seals hanging around." Now, 60 to 80 leopard seals wriggle ashore every year at Cape Shirreff, in the South Shetlands. At the region's largest fur-seal breeding ground, they kill more than half the newborn pups.

After commercial sealing stopped in Antarctica in the 1950s, fur seals started making a triumphant comeback. Scientists thought they



Often depicted on maps in white, the Antarctic Peninsula is now so warm that tufts of the continent's few native plants—as well as some invasives—are spreading.

A leopard seal nips at a young Adélie penguin before dragging it deep and drowning it near Antarctic Sound, at the peninsula's northern tip. These half-ton predators sometimes toy with penguins, slapping them against the sea surface. Typically leopard seals hunt alone from offshore ice floes. But with sea ice appearing later and disappearing sooner, they now often congregate close to shore, where the penguin colonies are.

PAUL NICKLEN

NEXT PHOTO

On a morning when five leopard seals could be seen circling nearby, these chinstrap, gentoo, and Adélie penguins raced ashore, stumbling and bumping into one another on their way back to their respective colonies.

KEITH LADZINSKI

would adapt well to a warming climate. Now their numbers at Cape Shirreff are declining 10 percent each year. "What we're seeing is extraordinary," Krause says. "No one saw this coming."

NO ONE FORESAW the good news either—the boom in humpback whales.

Starting in the early 20th century, industrial whalers drove most of Antarctica's cetaceans nearly to extinction, and many species are still struggling. Blue whales, for example, are thought to have numbered about a quarter of a million around 1900; the population today is 5 percent of that. But Antarctic humpbacks are roaring back: Their population is rising by 7 to 10 percent a year. "They're going bonkers!" Ari Friedlaender shouts as we dart across the water in an open skiff in the Palmer Archipelago, where we rendezvoused with him.

Friedlaender, a marine ecologist with the University of California at Santa Cruz and a National Geographic explorer, has been studying humpbacks off Antarctica since 2001, tracking how and where they move and feed. He has recorded them rolling and playing with one another and diving deeper than anyone expected. He's seen them opening gashes in ice with their blowholes. For animals that can weigh up to 40 tons, all this requires a lot of energy—and for now, he says, climate change is making more fuel available.

Friedlaender saw his first sign of that on a cruise in May 2009. It was late fall, so he and his colleagues assumed the humpbacks would have long since left for their wintering grounds near Ecuador and Panama. Then an echo-sounder detected a blob of krill that spread for miles below the ship. "We woke the next day, and there were more whales than any of us had ever

A skua bathes in a tide pool. Skuas prey on penguin eggs and chicks, fish, and krill. They also act as scavengers—the Antarctic equivalent of vultures, on constant cleanup duty in a place where carcasses don't decompose because of the icy cold.
KEITH LADZINSKI

seen at any time, at any place on the planet," says Friedlaender, who has also studied them off Alaska, California, and New England. They counted 306 humpbacks in a 10-mile stretch. "They were here because there was no ice."

Humpbacks, he explains, used to leave Antarctica in late March or early April, when sea ice closed in. Now they have many more ice-free weeks with more open water in which to roam widely and feed on krill. Those beady-eyed, translucent creatures are the size of a child's pinkie, but they travel in thick swarms that can stretch for miles, with 78,000 or more in a single cubic yard. Humpbacks are sticking around and fattening up on krill, and that's fueling a population boom. Female whales are producing calves every year. Lactating mothers have so much strength they're feeding newborns while pregnant. "That's insane for an animal that big," Friedlaender says.

He pulls alongside a humpback and her calf, resting in brash ice. The skiff bobs as Friedlaender, like some ponytailed modern harpooner, raises a long shaft above his head. The business end holds a waterproof camera fitted with suction cups. Friedlaender steadies his quivering weapon, takes aim, then slaps the camera on the leviathan's back. The surprised whale makes a sound like a wet snore. Both mother and calf dive.

"Felt like a great stick!" Friedlaender yells. For a day or two, until it falls off and floats to the surface to be retrieved, the camera will record a whale's-eye view of the sea. Humpbacks fare far and deep with few natural competitors. But how well they fare now depends on us.

A FEW YEARS AGO, an icebreaker dragged research nets around the Palmer Archipelago, looking for Antarctic silverfish—oily, sardinelike creatures that spawn beneath sea ice. They used to be the dominant fish off the western peninsula, composing half of what some Adélie penguins ate. But the team, led by Joseph Torres of the University of South Florida, towed day and night around Anvers and Renaud Islands and never caught a single silverfish. In waters that have experienced some of the greatest sea-ice declines, the fish had all but disappeared. Meanwhile scientists noticed penguins gulping more krill—even though it can take 20 krill to match the caloric value of one silverfish.

Will there be enough krill to go around? It's

not an easy question. Penguins and humpbacks eat krill, but so do skuas, squid, fur seals, and crabeater seals. Leopard seals sometimes eat krill. A blue whale eats millions a day. Animals that don't eat krill often feed on prey that does. Antarctica loves fatty krill. So do we.

In the 1960s, seeing a potential new seafood source, Soviet fleets began circling the continent. Today about 10 ships a year catch krill, led by Norway, South Korea, China, Chile, and Ukraine. The catch turns up in omega-3 pills and chewable krill-oil gummies and farmed salmon. In Ukraine peeled krill is sold in tins, like sardines. Sometimes krill gets processed at sea, boiled and dried into powder on huge trawlers.

After almost a month at sea we finally see one, in the Bransfield Strait, off the South Shetlands. A storm rocks the 333-foot *Long Da,* a Chinese mid-water factory trawler, as we pull along her stern. The boat's net courses through the water like a gape-mouthed whale shark. As the crew haul it in, the net's green mesh curls over itself, cocooning millions of krill.

For now, krill around Antarctica remain abundant. Trawlers net only a tiny fraction of the continent's krill. Fishing is tightly managed by 24 countries and the European Union, organized as the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR). But krill populations are cyclical, and researchers can't say how quickly or severely warming and loss of ice may affect them. "We measure krill and may think we understand it, but we don't, really," says Christian Reiss of NOAA Fisheries.

Many experts worry that krill boats could target and deplete krill on feeding grounds important for other wildlife. A team of U.S. government scientists in 2017 put it bluntly: "If predators and

Bones of blue whales still dot the peninsula's coast—a stark reminder of how fast humans can upend the natural world. After more than a century of whaling, much of it along these shores, the blue whale population is 5 percent of what it once was.
KEITH LADZINSKI

PREVIOUS PHOTO

Warm water and warm air sculpted this iceberg. As its base melted, says glaciologist Richard Alley, plumes of fresh meltwater flowed up its flanks, pulling in warm seawater that carved deep grooves. As the top melted, the iceberg became lighter and rose out of the water.
PAUL NICKLEN

the fishery use the same population of krill, it follows that removal of krill by one group may limit the availability to the other." Most fishing takes place where climate change has stressed animals the most—near the western peninsula. "Where is there also one of the greatest densities of predators?" Friedlaender asks. "Same place."

In 2017 Chile and Argentina proposed that CCAMLR place thousands of square miles west and north of the peninsula off-limits to krill fishing. Just this summer, environmental groups and Norway's AkerBioMarine, the largest krill-fishing company in the world, helped persuade most others in the krill industry to avoid fishing near penguin colonies during breeding periods next year. Starting in 2020, the companies say, they will stay at least 30 kilometers, or 19 miles, from penguin colonies year-round.

Many scientists and wildlife advocates maintain that permanent no-fishing zones regulated by CCAMLR are the safest solution. Otherwise, says Kim Bernard, an Oregon State University oceanographer who studies krill, "things could go very badly here. That really scares me."

ONE EVENING ON THE *Hans Hansson,* after a dinner of lamb and potatoes, Poncet traces a map in the galley, pointing out places he once chased krill with a butterfly net. It was common when he was a child to see massive swarms at the surface, he says. "Sometimes the engine would overheat because the water intakes were blocked with krill," Poncet recalls. Today "you almost never see them" in those places.

Scientists take Poncet's long experience seriously. "In a way, it's traditional knowledge," Bernard says. As Antarctica hurtles toward the unknown, scientific knowledge is still sparse.

This year Poncet abruptly sold the *Hans Hansson*. He says he and his companion, Juliet Hennequin—also an accomplished boat captain—were exhausted. But he also felt that too many visitors took the region's bounty for granted, just as it was changing into a place he barely recognized. "When I take stock of the current situation, the Antarctic Peninsula I knew as a child has already largely gone," he says. "I do wonder a lot what it will become." □

Photographer **Paul Nicklen** is still awestruck by his face time with a leopard seal in 2006. **Cristina Mittermeier** and **Keith Ladzinski** are also Antarctic veterans. This was **Craig Welch**'s first trip.

YOUR SHOT

LEINANI SHAK YOSAITIS

PHOTOS FROM OUR COMMUNITY

WHO

Leinani Shak Yosaitis, a former oil-industry worker turned photographer who lives in Las Vegas

WHERE

A hillside near the Ngorongoro Crater in northern Tanzania

WHAT

A Nikon D3S camera with a 70-200mm f/2.8 lens with a 1.7x converter

Yosaitis spent her honeymoon on a safari in Tanzania and Kenya. After leaving the Ngorongoro Crater, she and her new husband came upon a herd of about 25 giraffes. Most giraffes they'd seen had been eating tree leaves, which obscured a clean shot. But this particular herd stood under a clear blue sky, which complemented the animals' tawny coats. Yosaitis asked their driver to approach the giraffes slowly. The driver steered the safari truck off the main road (despite his concern about falling into a warthog burrow) and positioned the vehicle with the sun behind it. Two male giraffes began necking, a behavior of combative neck-swinging, likely used to establish dominance. Yosaitis caught the moment—less than a second long—when the males aligned and two heads appeared to extend from the same body.

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Arunachal Macaque *(Macaca munzala)*

Size: Head and body length, approx. 57.5 cm (22.6 inches); tail, approx. 26.4 cm (10.4 inches) **Weight:** 14 - 15 kg (30.9 - 33.1 lbs) **Habitat:** Open, subtropical, broadleaved and temperate forests **Surviving number:** Unknown

Photographed by Sandesh Kadur

WILDLIFE AS CANON SEES IT

High. Higher. Highest. The Arunachal macaque lives at higher elevations – up to roughly 11,000 feet above sea level – than any other species of macaque. Winter is bitterly cold at those altitudes and nutritious food is scarce, forcing it to survive on bark and what plants are available until a more fruitful season comes again. Females remain in the groups they are born into, while males disperse. But all are finding everyday life more and more dangerous as habitat loss and hunting reach even to the heights they call home.

As Canon sees it, images have the power to raise awareness of the threats facing endangered species and the natural environment, helping us make the world a better place.

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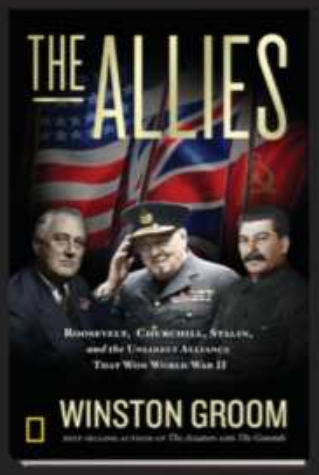

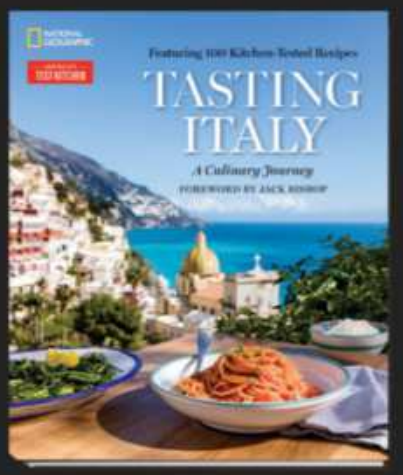

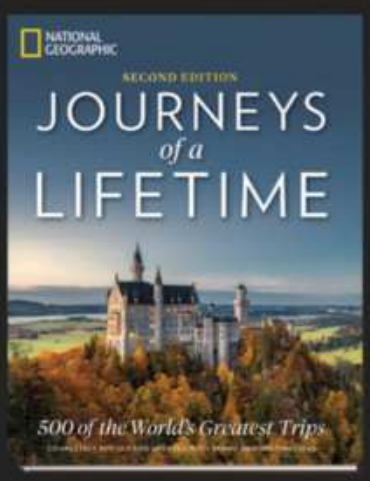

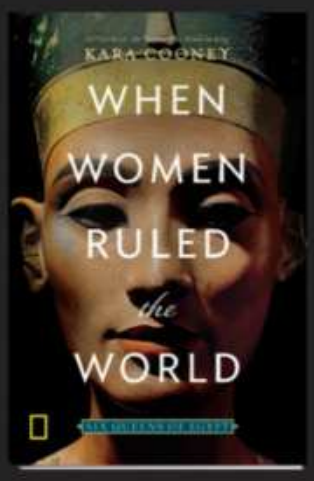

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